



Focus point on physics in the Balkans: perspectives and challenges

Luc Berge^{1,a}, Goran S. Djordjević^{2,b}, Zoran V. Popović^{3,c}

¹ Centre Lasers Intenses et Applications, Université de Bordeaux–CNRS–CEA, 33405 Talence Cedex, France

² Faculty of Science, University of Nis, Niš, Serbia

³ Serbian Academy of Sciences and Arts, Knez Mihailova 35, 11000 Belgrade, Serbia

© The Author(s), under exclusive licence to Società Italiana di Fisica and Springer-Verlag GmbH Germany, part of Springer Nature 2024

The primary objective of this EPJ + Focus Point is to contribute to reviewing the current state of physics research in the Balkans. As indicated by Milošević et al. [1], the overall scientific output of physicists from the Balkans, considering factors such as population size, investments in science, and others, aligns with global trends.

A distinctive feature of physics in the Balkans is the more than 30-year-old tradition of organizing triennial congresses, specifically the International General Physics Conferences, under the auspices of the Balkan Physical Union (BPU). For all nations represented as BPU Member Societies, including Albania, Bulgaria, Cyprus, Greece, Moldova, Montenegro, North Macedonia, Romania, Serbia, and Turkey, the BPU11 Congress has served as a platform to showcase the research achievements of numerous conference participants and their collaborators in the Balkans, Europe, and worldwide.

The 11th edition of this important event took place at the Serbian Academy of Sciences and Arts in Belgrade, Serbia, between August 28 and September 1, 2022, and it covered a broad range of experimental and theoretical research in Nuclear Physics and Nuclear Energy, Astronomy and Astrophysics, Gravitation and Cosmology, Atomic and Molecular Physics, High Energy and Particle Physics, Condensed Matter Physics and Statistical Physics, Optics and Photonics, Plasma and Gas-Discharge Physics, Theoretical, Mathematical and Computational Physics, Meteorology and Geophysics, Environmental Physics and Alternative Sources of Energy, Physics of Socioeconomic Systems and Applied Physics, Biophysics and Medical Physics, Physics Education, History and Philosophy of Physics, Metrology and Instrumentation.

Besides the prolific program dedicated to the above various scientific topics, the 11th BPU Congress also addressed physics-based societal issues through five round tables dealing with the roadmap for the future of high energy physics, the integration and widening participation in the European research funding program, careers in physics, quantum and new technologies, models of studying physics in European universities and specificities in Balkan countries. This event allowed for a narrow collaboration between the Balkan Physical Union and the European Physical Society (EPS) being both parts of the International Organizing Committee.

This EPJ + Focus point consists of eleven articles from the seventeen plenary and key lectures invited at the BPU11 Congress to contribute to this edition of EPJ +. We do believe that this Focus point will provide valuable insights in already well-established areas, as well as new interesting research avenues that remain to be explored. This issue mainly contains original scientific papers with review elements in Solid State Physics, Material Science, Quantum Optics and Laser Physics, Open Quantum Systems, Cosmology, Nuclear and Collider Physics.

More precisely, this Focus point gathers a number of review and original articles revealing the rich variety in the physics research undertaken in the Balkans.

For example, T. Mihaescu and A. Isar from Bucharest's Horia Hulubei National Institute of Physics and Nuclear Engineering present new analytical results on the Markovian time evolution of the entropy production rate as a measure of irreversibility created in a quantum system of two coupled bosonic modes interacting with a thermal environment [2]. In the field of experimental high energy physics, D. Joković et al. from Institute of Physics of Belgrade University address the important problem of cosmic-ray muon-induced background in gamma spectroscopy from an underground muon detector by means of experimental spectra and Geant4-based simulation results [3]. In the same discipline, V. V. Gligorov and V. Reković from Sorbonne University, Paris and Institute for Nuclear Sciences of Belgrade University review the history of real-time data processing for collider experiments with special emphasis on the Large Hadron Collider and planned upgrades over the next decade [4]. In the field of astrophysics and astronomy, D. Huterer from the University of Michigan discusses the so-called “Hubble tension,” i.e., discrepancies in cosmological measurements of the universe expansion and related development in cosmology over the past years [5]. B. Arbutina from Belgrade University revisits the theory of diffusive collisionless shock acceleration of particles by incorporating electron heating, resonant

^a e-mail: luc.berge@u-bordeaux.fr

^b e-mail: gorandj@junis.ni.ac.rs (corresponding author)

^c e-mail: zoran.popovic@sanu.ac.rs

and non-resonant magnetic field instabilities as well as corrections due to escaping protons and electron-induced synchrotron losses [6].

In photonics and laser-matter interaction, C. Farcău from Cluj-Napoca Babeş-Bolyai University explores the optical properties of colloidal plasmonic–photonic crystals consisting of silver films deposited over linear arrays of polystyrene microspheres and their potential use for applications based on surface-enhanced Raman spectroscopy or fluorescence [7]. Furthermore, L. Stoyanov et al. from Sofia University, Skopje's Institute of Physics and Jena University, present an exhaustive review of optical vortices carrying phase singularities and address experimental methods enabling to determine and modify their topological charges [8]. In closer connection with the latest Nobel prize winners, D. B. Milošević from Sarajevo University details interesting developments of the quantum-orbit theory in strong-field physics to describe photoelectron momentum distributions in high-harmonic generation. New results are reported on terahertz-pulse-assisted strong-field ionization [9]. In material science E. V. Monaico et al. from the Technical University of Moldova compare the performances of three types of microstructures taken as substrates for electrochemical deposition of gold nanodots; the morphology of the produced hybrid microarchitectures is investigated by scanning electron microscopy and new platforms for developing 3D hybrid micro-nano-architectures via vapor–liquid–solid deposition are proposed [10]. In superconductor physics, Z. Popović and P. Miranović from the Universities of Belgrade and Montenegro review a quantitative theory describing quasiparticle transport properties in superconductor junctions that may help experimentally determine the value of weak exchange field in ferromagnets and the order parameter of superconductors [11]. To end with, from a more societal point of view, M. Maragakis et al. from Aristotle University of Thessaloniki carry out an investigation of patent citation data from the European Patent Office to establish a time-series analysis of correlations between patent classes and thereby trace technological jumps, as modifications in bonds between pairs of patent classes can point to a changing landscape in scientific innovation [12].

As can be guessed from the above panorama of research activities, physics in the Balkans is doing well and is expected to play an even more important role in the international community. We are thus proud to propose this series of articles not only to the Balkan community, but also to researchers working in different continents and hope that this volume will help foster future fruitful cooperation between Balkan physicists and the rest of the world. We have no doubt that the objective of this EPJ + Focus point will be reached and will encourage our colleagues to get closer and closer to Balkan physicists in the coming years.

We express our sincere gratitude to EPJ + and the many referees for their excellent collaboration and valuable contributions to this volume. Our heartfelt thanks go to numerous institutions and individuals who have supported BPU11 and fostered a broad cooperation network involving hundreds of researchers. We particularly appreciate the financial support from international institutions such as EPS, CERN, ICTP, and CEI (Trieste).

References

1. M. Milosevic et al., Balkan web of physics. AIP Conf. Proc. **2075**, 180011 (2019). <https://doi.org/10.1063/1.5091408>
2. T. Mihaescu, A. Isar, Irreversibility and entropy production in two coupled bosonic modes interacting with a thermal environment. Eur. Phys. J. Plus **139**, 82 (2024). <https://doi.org/10.1140/epjp/s13360-024-04869-x>
3. D. Joković et al., Application of Geant4 simulation in measurement of cosmic-ray muon flux and studies of muon-induced background. Eur. Phys. J. Plus **138**, 1006 (2023). <https://doi.org/10.1140/epjp/s13360-023-04639-1>
4. V.V. Gligorov, V. Reković, Review of real-time data processing for collider experiments. Eur. Phys. J. Plus **138**, 1005 (2023). <https://doi.org/10.1140/epjp/s13360-023-04599-6>
5. D. Huterer, Hubble tension. Eur. Phys. J. Plus **138**, 1004 (2023). <https://doi.org/10.1140/epjp/s13360-023-04591-0>
6. B. Arbutina, Nonlinear diffusive shock acceleration of cosmic rays: quasi-thermal and non-thermal particle distributions. Eur. Phys. J. Plus **138**, 863 (2023). <https://doi.org/10.1140/epjp/s13360-023-04500-5>
7. C. Farcău, Linear arrays of metal-coated microspheres: a polarization-sensitive hybrid colloidal plasmonic–photonic crystal. Eur. Phys. J. Plus **138**, 827 (2023). <https://doi.org/10.1140/epjp/s13360-023-04638-2>
8. L. Stoyanov et al., Optical vortices in brief: introduction for experimentalists. Eur. Phys. J. Plus **138**, 702 (2023). <https://doi.org/10.1140/epjp/s13360-023-04227-3>
9. D.B. Milošević, Application of quantum-orbit theory to atomic processes in strong tailored laser fields and terahertz pulses. Eur. Phys. J. Plus **138**, 356 (2023). <https://doi.org/10.1140/epjp/s13360-023-03962-x>
10. E.V. Monaico et al., Gold coated microstructures as a platform for the preparation of semiconductor-based hybrid 3D micro-nano-architectures. Eur. Phys. J. Plus **138**, 827 (2023). <https://doi.org/10.1140/epjp/s13360-023-04462-8>
11. Z. Popović, P. Miranović, Current–voltage characteristics and conductance spectra in s-wave or d-wave superconductor/ferromagnet/superconductor heterojunctions: role of Andreev reflection. Eur. Phys. J. Plus **138**, 767 (2023). <https://doi.org/10.1140/epjp/s13360-023-04394-3>
12. M. Maragakis et al., Tracing technological shifts: time-series analysis of correlations between patent classes. Eur. Phys. J. Plus **138**, 776 (2023). <https://doi.org/10.1140/epjp/s13360-023-04344-z>