PREFACE

The 2019 Mazurian Lakes Conference on Physics was held in Piaski, a vacation resort located at the lake of Bełdany in the heart of the Great Mazurian Lakes District, from the 1^{st} to 7^{th} of September 2019. It was the 36^{th} meeting in a series initiated over 50 years ago, in 1968, by Professor Zdzisław Wilhelmi and his students and collaborators. Throughout these years, the Mazurian conferences have gained a world-wide reputation for their high scientific merit and a unique atmosphere. The 36^{th} meeting was organized by the University of Warsaw, the National Centre for Nuclear Research and the Pro-Physica Foundation, and chaired by Wojciech Satuła (University of Warsaw) and Krzysztof Rykaczewski (vice-chair, ORNL Oak Ridge). We acknowledge the generous support provided by the University of Warsaw through the Faculty of Physics, Institute for Experimental Physics and Institute for Theoretical Physics, the National Centre for Nuclear Research and NuPECC.

The title *Probing fundamental laws of nature with exotic nuclei and atoms* was adopted for the 2019 Conference. It highlighted the fundamental aspects of nuclear and atomic physics, and their sensitivity to the signals allowing us to search for new physics in ways that are complementary to other approaches.

The program was arranged with the invaluable help of the International Advisory Board (see the list earlier in this volume, and on `http://mazurian.fuw.edu.pl`), and was built around several main topics:

— Challenges at the interface of atomic and nuclear physics,

— Recent advances and prospects for nuclear theory,

— Fundamental properties of subatomic matter,

— Nuclear structure and reactions,

— Nuclear astrophysics and nucleosynthesis,

— Super-heavy elements and nuclear fission,

— Innovative experimental techniques and facilities and

— Interdisciplinary studies and societal applications.

Our conference attracted 149 physicists from 25 countries and 66 institutions, including a large number of young researchers. There were 88 oral contributions and 68 posters presented.

The program consisted of 30-minute lectures, and many shorter presentations ranging from 5 to 15 minutes, as well as the poster presentations in the evening. Posters were available for viewing and discussions with their authors for the whole duration of the conference.

The Conference began, following the tradition, on Sunday evening with a general lecture — this year on applications of nuclear physics to history and ancient art. The impressive presentation on the *Virtual unfolding of folded papyri* was given by a long-term friend of the Mazurian meetings, Heinz-Eberhard Mahnke.

Already on the first day of the conference, a wide range of topics was covered. We benefited from lectures on the recent observations of gravitational-wave signals to constrain the nuclear equation of state (Andreas Bauswein), and how results of mass measurements can be of aid in the understanding of neutron star mergers (Ani Aprahamian). Further, much more sensitive neutrino mass measurements within Project 8 were presented by Walter Pettus, and a search for very exotic systems of tri- and tetra-neutrons was reported by Hide Sakai. The meeting continued with lectures on the physics of cold radioactive atoms (Yasuhiro Sakemi), a nuclear clock based on the ultra-low energy ^{229}Th isomer (Peter Thirolf), two-proton radioactivity (Marek Pfützner, Jérôme Giovinazzo), and a search for physics beyond the Standard Model with radioactive beams of ^{32}Ar (Dinko Atanasov).

The dominating topics for lectures on the second day were modern theoretical approaches to atomic and nuclear physics. The physics of super-heavy atoms was analyzed by Peter Schwerdtfeger and Anastasia Borschevsky, while Krzysztof Pachucki discussed nuclear charge radii derived from the isotope-shift measurements in ordinary and muonic atoms. Nuclear structure calculations aided by quantum computers were presented by Titus Morris, while Evgeny Epelbaum, Piotr Magierski, Jacek Dobaczewski, Maciej Konieczka, and Guillaume Hupin presented theoretical results on deuteron form-factors, exotic aspects of superfliud dynamics, properties of density functionals, the V_{ud} matrix element, and thermonuclear fusion reactions, respectively.

We continued on the third day on the topic of nuclear astrophysics with presentations on neutron sources for the i-process (Michael Wiescher), experimentally constrained (n,γ) reaction rates (Magne Guttormsen), precise mass measurements (Anu Kankainen), and the $d + {}^{7}$Be cross sections for Big-Bang nucleosynthesis (Ingo Wiedenhöver). These were followed by reviews of results achieved at leading laboratories and experimental facilities including RIBF at RIKEN (Naoki Fukuda), ISOLDE and HIE-ISOLDE at CERN (Gerda Neyens), the radioactive-ion spin orientation technique (Hideki Ueno), the Polarex facility for on-line nuclear orientation (Rémy Thoër), nu-ball experiments (Jonathan Wilson), and precision beta-decay

measurements (Karolina Kolos). This topic was continued on Friday morning with a presentation by Calin Ur on the exploration of the intimate structure of matter at ELI-NP, and by Thomas Cocolios on Tb-IRMA-V: Terbium ISOL Radioisotopes for Medical Applications. Nicholas Scielzo summarized the nuclear data needs for other applications, from nuclear weapons to prostate cancer therapy.

Our contribution to the celebration of 2019 as the *International Year of the Periodic Table*, as proclaimed by the United Nations/UNESCO, was a session on various aspects of the studies of super-heavy nuclei. The talks of this session covered the status and perspectives of super-heavy element research at RIKEN (Hiromitsu Haba), precision measurements of nuclear properties of No, Lr and Rf isotopes at SHIP (Michael Block), fission studies using multi-nucleon transfer reactions, and a unique ^{254}Es target (Katsuhisa Nishio), as well as two talks representing the recent results of Polish superheavy-elements theory school started decades ago by Zdzisław Szymański and Adam Sobiczewski (Michał Kowal, Janusz Skalski). Bertis Rasco and Robert Grzywacz continued with nuclear structure and fundamental aspects of beta-decay studies with modern methods, while Marek Płoszajczak discussed near-threshold collectivity in nuclei. Various aspects of light nuclei were addressed by Michał Ciemała, Raúl de Diego, and Antonio Caciolli.

A session on the last day honoured the recipients of the Zdzisław Szymański award (Javier Menéndez), of the Tomek Czosnyka award (Katarzyna Wrzosek-Lipska), as well as the best poster awards (Ryan Llewellyn, Paweł Bączyk, Varvara Lagaki, Juan Saiz Lomas) sponsored by NuPECC. The conference was concluded by Marek Lewitowicz presenting a summary of the European strategy for nuclear physics as seen by NuPECC, and Witek Nazarewicz discussing challenges in nuclear theory.

A diverse social program that included activities like sailing with the one-race regatta, won by an international crew led by Rémy Thoër, camp fire with the international song contest, a classical music concert in the picturesque neo-gothic evangelical church in Wejsuny, and a crash course on the traditional Polish dance "Polonez" at the conference dinner, contributed to the unforgettable atmosphere of the Conference.

The Mazurian Conference ended with an invitation to the next nuclear physics conference in Poland, organized by physicists from Kraków, to be held in Zakopane in August/September 2020. The 37$^{\text{th}}$ Mazurian Lakes Conference on Physics will be held in the first week of September 2021, again in the Mazurian Lakes district.

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