

## PREFACE

The Cracow Epiphany Conference has featured a different topic each year since its inception in 1995. By introducing new subjects and inviting new participants annually, the meetings provide a broad forum for discussing the frontiers of physics.

The 31<sup>st</sup> Cracow Epiphany Conference was dedicated to reviewing and discussing recent results obtained at the Large Hadron Collider (LHC). The Henryk Niewodniczański Institute of Nuclear Physics of Polish Academy of Sciences hosted the conference on 13–17 January, 2025. These proceedings cover most of the topics presented during the conference, including:

- The LHC accelerator status,
- Electroweak physics,
- QCD theory,
- Standard Model Higgs,
- Beyond Standard Model searches,
- Top-quark physics,
- Heavy-flavours physics,
- Heavy-ions physics,
- Exotica searches and future accelerators,
- LHC detectors' upgrades.

A special session was held to celebrate Professor Kacper Zalewski's 90<sup>th</sup> birthday. During this session, presentations were given by distinguished guests, students, and colleagues of Professor Zalewski, and the Jubilarian himself. Let us now list these presentations:

- M. Kucharczyk, *Quantum correlations in the hadronization process*;
- K. Kutak, *Entanglement entropy, Krylov complexity and DIS data*;
- M.A. Nowak, *Entropy production and fluctuation–dissipation theorem*;
- P. Błasiak, *All non-local states of identical particles, or when indistinguishability is a resource*;
- A. Horzela, *Lecturer, Teacher and Mentor: What I have learned from Professor Zalewski?*;

- K. Życzkowski, *Statistical physics, entropy and quantum entanglement*;
- K. Zalewski, *Particle physics in Kraków*.

Most of the contributions from this session are collected in this book.

One of the main goals of the Epiphany conference is to activate Ph.D. students and young scientists by enabling them to present the results of their work during dedicated sessions. During the 31<sup>st</sup> edition of the Conference, four such sessions were organised.

We thank the members of the Local Organising Committee for their help in setting up the conference program. We also thank the directorate and administration of the Henryk Niewodniczański Institute of Nuclear Physics Polish Academy of Sciences, for their assistance in organising the conference. We are grateful to the Polish Academy of Sciences for co-organisation and financial support. We also appreciate *Acta Physica Polonica B* for their help in preparing this proceedings volume.

Finally, let us once again thank all the speakers for their participation, which made the conference a successful event

The electronic materials from the conference are also available at:

<https://epiphany.ifj.edu.pl/epiphany2025/>

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