52nd International Symposium on Multiparticle Dynamics (ISMD 2023) – X17 confirmed

Between 21 and 26 August 2023, 129 physicists from 32 countries across 5 continents attended the 52nd International Symposium on Multiparticle Dynamics held on the Károly Róbert Campus of the Hungarian University of Agriculture and Life Sciences in Gyöngyös, Hungary. Over the one-week period, a total of 128 scientific reports were delivered at the international conference organised jointly by the Wigner Research Centre for Physics, Budapest, the Károly Róbert Campus of the Hungarian University of Agriculture and Life Sciences (MATE KRC, Gyöngyös), and the Eötvös Loránd University (ELTE, Budapest).

The last few editions of the ISMD series were organized by the National University of Singapore, Singapore in 2018, by the Los Alamos National Laboratory, NM, USA in 2019, and the University of Edinburgh, Scotland, Great Britain in 2021 and 2022. The Board of Elders of ISMD 2023 decided that the next edition, ISMD 2024 will be organized in Malargüe, Argentina, frequently used by the AUGER collaboration for their meetings.

Numerous current research topics related to multiparticle dynamics were presented at ISMD 2023 in Hungary, including

- Collectivity in high energy collisions: jets and flows
- Cosmic ray and astroparticle physics
- Femtoscopy
- Forward physics: Diffraction, Odderon and Pomeron
- Hadronic final states in high p_T interactions
- Multiparticle correlations and fluctuations
- Proton structure, small-x and large-x physics
- Physics of X17 and other beyond standard model states
- Other important new developments in HEP
- Science outreach in Tokaj, Hungary

Three out of the above ISMD 2023 topics attracted particularly large interest. **The greatest international interest was generated by the latest research results concerning the subatomic particle candidate known as X17, which had been discovered at the Hungarian Research Network Institute for Nuclear Research (ATOMKI) located in Debrecen, Hungary. Attila Krasznahorkay, Member of the Academy of Europe,** professor of experimental nuclear physics presented the latest findings of his research group, confirming their previous measurements in the context of a new nuclear physics process and using a new measuring instrument. Professor Cheuk-Yin Wong (Oak Ridge National Laboratory, TN, USA) presented his theoretical interpretation of X17 as a QED meson, predicted in 2010. In this way, X17 and E38 correspond to new kind of quark-antiquark bound states, where the strong force plays the role of a background field only, and the binding is due to the electromagnetic interaction between positively and negatively charged quarks and antiquarks. The existence of X17 has been confirmed at ISMD 2023 by Hungarian, Russian and Vietnamese experimental groups. Professor S. Varró, a theorist from ELI-ALPS, Szeged and Wigner RCP, Budapest, Hungary, confirmed the predictions of professor Wong providing an electromagnetic mass formula for X17. The existence of E38 has been experimentally confirmed by the report of Dr. Kh. Abraamyan of JINR, Dubna, Russia. Several experimental groups reported the construction of control experiments to cross-check the existence of X17 and E38 particle candidates.

The nearly perfect fluid behavior, observed experimentally in high energy collisions of elementary proton-proton and heavy ion collisions has drawn also great attention, even excursion time has been shortened to allow time for presenting the new experimental and theoretical results in this section. MDPI Universe sponsored the best young speaker and best poster prizes of ISMD 2023 and both winners selected were presenting results related to this topic of collectivity in small and large colliding systems at high energies. **Ms. Archita Rani Dash Ph.D.** (University of Münster, Münster, Germany) has been selected as **the best junior speaker of ISMD 2023** by the vote of the International Advisory Committee and the Board of Elders for her talk entitled „Recent Jet Measurements in Pb-Pb Collisions with ALICE". Similarly, **Mr. Dániel Kincses, Ph.D.** (Eötvös University, Budapest, Hungary) has been selected as the **best poster speaker of ISMD 2023**, for his flash/poster talk entitled „Pion interferometry with Lévy-stable sources in $\sqrt{s_{NN}}$ = 200 GeV Au+Au collisions at STAR".

52nd International Symposium on Multiparticle Dynamics (ISMD 2023) in Gyöngyös, Hungary

The third highlighted topic of ISMD 2023 was related to the solution of a 50 years old particle physics puzzle, the statistically significant experimental observation of odderon-exchange, predicted theoretically by **B. Nicolescu and L. Lukaszuk in 1973**. The **first paper on a statistically significant signal of odderon exchange** was published in February 2021 in the European Physics Journal C (EPJ C) by a Hungarian-Swedish team. This result, based on a meta-analysis of public domain, published D0 and TOTEM experimental data and a newly found scaling law in elastic proton-proton scattering data has been extended to 8 TeV in the talk of A. Ster. The second, statistically significant signal of odderon exchange was published by a Hungarian team in EPJ C in July 2021 using a generalization of a model proposed by Polish authors. These results were extended at ISMD 2023 to 8 TeV and to low-t by the talks of T. Csörgő and I. Szanyi. The third statistically significant observation and the **first result based on newly measured experimental datapoints** was published by the D0 and TOTEM

Collaborations in the Physical Review Letters in August 2021. Between 2021 and 2023, at least three papers were published in respected journals of high energy particle and nuclear physics, like Physical Review D, Physics Letters B, and EPJ C, that question the validity of the D0-TOTEM proof of Odderon exchange. **These criticisms were answered** at ISMD 2023 by K. Österberg (University of Helsinki, Helsinki, Finland), the physics coordinator of the TOTEM experiment.

ISMD 2023 was closed with a science outreach section, where several secondary school students participated online from Croatia, Hungary, Mexico, Poland and The Netherlands. The last talk was given by the secondary school student Zsóri Georgina Anna from the Science Club of the Berze Secondary School in Gyöngyös, Hungary. She presented a newly developed card game entitled „Find you own Odderon!". **The students of the were able to find their odderon within about two minutes, playfully. The same task lasted for nearly 50 years for the professors of physics, not so much playfully but scientifically, according to the strict rules of high energy elementary particle physics.**

All the ISMD 2023 presentations are archived at

https://indico.cern.ch/e/ismd23 .

The organization of ISMD 2023 would have been nearly impossible without the support of **several civil, local and international sponsors**. We would like to express our gratitude to all the **ISMD 2023 sponsors** for their invaluable support and generousity.

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This ISMD 2023 scientific report has been closed in Gyöngyös, Hungary as well as in Catania, Italy, on November 8, 2023 by

Prof. Tamás Csörgő, MAE, Chair of ISMD 2023,
Prof. Máté Csanád, MYAE, Scientific Secretary and
Dr. Tamás Novák, Ph.D, Co-chair of ISMD 2023.