

Foreword to the Proceedings of the Corfu Summer Institute “School and Workshops on Elementary Particle Physics and Gravity” (CORFU2024)

Dedicated to the memory of the Academician Professor Ivan Todorov

1. Foreword

These are the Proceedings of the scientific activities of CORFU2024, the 24th Hellenic School and Workshops on Elementary Particle Physics and Gravity, which took place from May 12th to May 26th and from August 25th to September 27th, 2024. The Workshops and the School were hosted by the European Institute for Sciences and their Applications (EISA)-link in the conference center of the former Royal Palace Garden of Mon Repos in Corfu, Greece. The CORFU2024 activities consisted of four International Workshops, two International Conferences and one Summer School bringing together world class senior scientists and young researchers to interact and forge new collaborations.

Specifically, the CORFU2024 hosted the following sessions:

- **From Fundamental Physics to Data Analysis in Cosmology**, May 12 - May 19, 2024
- **Workshop on Future Accelerators**, May 19 - May 26, 2024
- **Workshop on the Standard Model and Beyond**, Aug 25 - Sep 04, 2024
- **Workshop on Quantum Gravity, Strings and the Swampland**, Sep 03 - Sep 09, 2024
- **The Dark Side of the Universe, DSU2024**, Sep 08 - Sep 14, 2024
- **Workshop on Noncommutative and Generalized Geometry in String Theory, Gauge Theory and Related Physical Models**, Sep 17 - Sep 24, 2024
- **International Atmospheric Circulation Reconstructions over the Earth (ACRE) Drought and Flood Conference**, Sep 23 - Sep 27, 2024

All talks can be found on the homepage of CORFU2024:

physics.ntua.gr/corfu2024

In parallel to the main scientific programme, a rich programme of outreach activities took place. This included master classes for high school students, seminars for high school teachers, open talks for the general public in the Labs of Physical Sciences and in the building of the Society of Corfiot Studies - Corfu Solomos Museum, exhibitions of CERN and Gravitational Waves in the

Foyer of the Corfu Municipal Theater, interviews in the media (TV, radio and newspapers). In addition, the receptions of the social programme of the various sessions were enriched with cultural events given by the Women's Choir of Corfu, Philharmonic Society of Skripero and the Philharmonic Society of Corfu.

These proceedings are dedicated to the memory of the Academician Professor Ivan Todorov.

Ivan Todorov passed away on February 14, 2025. The Academician of the Bulgarian Academy of Sciences Professor Ivan Todorov was a great scientist whose academic achievements have left an indelible mark on the field of Theoretical and Mathematical Physics. Internationally renowned for his fundamental contributions to the axiomatic foundations of quantum field theory, conformal field theories, and group-theoretical methods, Ivan Todorov was also a remarkable individual, characterized by his warmth and intellectual generosity.

Ivan Todorov was a cherished friend of the Corfu scientific activities, gracing the events with his presence and contributions on several occasions. We had the pleasure of admiring his scientific acumen and gentle, warm personality in Corfu, Varna, CERN, Athens, and elsewhere, and we developed a lasting friendship with him and his wife, Boryana, for which we are deeply grateful.

We join the chorus of voices expressing profound sorrow at the loss of such a remarkable individual. The memory of Ivan Todorov will remain with us always. We extend our deepest condolences to Boryana and the rest of his family, his colleagues and students at the Institute for Nuclear Research and Nuclear Energy in Sofia, and to all those across the world who carry forward his spirit.

One can read more about Ivan Todorov's celebrated life (eisa.institute/news.html#todorov) and to an article written by his friends and colleagues, [PoS \(CORFU2024\)391](#), which appeared also in the CERN Courier.

The Corfu Summer Institute has a very long, interesting and successful history. The Corfu Meetings started as a Summer School on EPP mostly for Greek graduate students in 1982, and since then, it has developed into a leading international Summer Institute in the field of elementary particle physics (covering both experimental and theoretical advances) and more recently of gravity and cosmology. In addition, it has launched a very rich outreach program to teachers and school students and general public that has been widely appreciated by the local society and scientific community over the years.

The structure of the "Summer Institute on EPP and Gravity 2024" was based on the general format developed, established and tested in all previous Corfu Meetings. It was hosted by the

European Institute for Science and their Applications (EISA), which has been the host of the meetings since its foundation in 2006. EISA aims to serve as a permanent extension of the Corfu Summer Institutes, with the additional target of attracting first class scientists who can stay in Corfu for a long period and produce locally a significant research output. The scientific activities of CORFU2024 were held in the conference hall and in the town of Corfu, which is the permanent basis of EISA.

As we have reported several times during recent years, we have had a very exciting development. The Corfu Municipality, responding to a call for proposals by the central Government, submitted a proposal for the renovation of three old buildings in the garden of Mon Repos. The proposal was approved, and the grant provided the funding for the realization of this project. The renovation of the buildings has been completed and soon is expected the constructors to return them renovated officially to the Municipality of Corfu in order to be used by EISA. This means that, hopefully, the dream of having buildings in Mon Repos hosting the participants of the EISA's scientific activities and providing them with office space and the necessary infrastructure will be realized soon! With this opportunity, we would like to thank very warmly MPP in Munich for the computers and the rest of the infrastructure. In particular, we would like to thank the acting directors Wolfgang Hollik, Allen Caldwell and Dieter Lust for their generous offers over the years and Thomas Hahn for realizing this project. Equally, very warm thanks are due to ITP Heidelberg and to Christof Wetterich for their generous technical equipment offer.

Based on the renovation of the buildings in Mon Repos we are starting a new campaign, namely to make serious and specific scientific plans with the scientific personel of the ~ 20 Universities and Institutes that constitute the EISA on the way that the buildings should be used. It is well known that most of the main Institutions in Europe have a problem with space (offices and halls) and have difficulties to host scientific activities. Now that our dream to have such space in Corfu Mon Repos is close to being realised, it is our duty to use it in the best possible way. We plan visits to all Institutions of EISA to discuss with their leaderships and colleagues concerning the best way to use the Mon Repos buildings. In addition, all constructive ideas are most welcome!

The first event, ***From Fundamental Physics to Data Analysis in Cosmology***, is the first School of the CosmoVerse COST Action. It took place from 12 to 19 May 2024. It was co-organized and supported by:

- The National Technical University of Athens
 - The Municipality of Corfu
 - The Ionian University, and
 - The Regional Government of the Ionian Islands (Periphery of the Ionian Islands).
- and It has attracted 55 young scientists.

The detailed program of the School can be found at:

<https://cosmoversetensions.eu/event/cosmoverseschoolcorfu/>

The Organizing Committee was:

OJ. Levi Said (U Malta), E. Di Valentino (Sheffield U), N. Frusciante (UNINA), A. Pollo (National Center for Nuclear Research), R. Wojtak (DARK Niels Bohr Inst), L. Perivolaropoulos (U Ioannina) E.N. Saridakis (National Observatory of Athens)

The second event, **Workshop on Future Accelerators**, took place from 19 to 26 April 2024. It was co-organized by:

- The National Technical University of Athens
- The Municipality of Corfu
- The Ionian University, and
- The Regional Government of the Ionian Islands (Periphery of the Ionian Islands).

It has attracted 50 senior scientists; 40 of them have presented their current research project as workshop speakers.

The detailed program of the Workshop can be found at:

<https://indico.cern.ch/event/1349196/timetable/#all>

The Organizing Committee was:

T. Behnke (DESY), A. Blondel (LPNHE/Geneva), J. Kalinowski (U Warsaw), K. Kordas (Aristotle U Thessaloniki), O. Kortner (Max Planck Inst. für Physik), M. Mangano (CERN), F. Simon (KIT), E. Tsesmelis (CERN), F. Zimmermann (CERN), G. Zoupanos (NTU Athens).

The third event, **Workshop on the Standard Model and Beyond** took place from 25 August to 4 September 2024. It was co-organized by:

- The National Technical University of Athens
- The Municipality of Corfu
- The National Observatory of Athens
- The Ionian University, and
- The Regional Government of the Ionian Islands (Periphery of the Ionian Islands).

It has attracted 102 senior and young scientists; 90 of them have presented their current research project as workshop speakers.

The detailed program of the Workshop can be found at:

<https://indico.cern.ch/event/1426375/timetable/#20240825>

The Organizing Committee was:

K. Anagnostopoulos (NTUA), J. Kalinowski (Warsaw U.), K. Kordas (Aristotle U Thessaloniki), M.N. Rebelo (CFTP/IST/U. Lisboa), E. Saridakis (NOA), G. Zoupanos (NTUA).

The Advisory Committee was:

F. del Aguila (Granada U.), J.A. Aguilar Saavedra (Granada U.), K. Anagnostopoulos (NTU Athens), I. Antoniadis (Bern U. and LPHE-CNRS), P. Apostolopoulos (Ionian U.), R. Barbieri (SNS Pisa), M.B. Gavela (Autonoma U. Madrid), D. Ghilencea (IFIN), N. Glover (Durham U. IPPP), A. Hell (LMU Munich), W. Hollik (MPI Munich), J. Kalinowski (U Warsaw), K. Kordas (Aristotle U Thessaloniki), G. Koutsoumbas (NTU Athens), N. Mavromatos (NTU Athens), M. Neubert (Johannes Gutenberg Universitat Mainz), C. Papadopoulos (NCSR Demokritos), R. Pittau (U. Granada), M.N. Rebelo (T.U. Lisbon), A. Ringwald (DESY), G. Rodrigo (IFIC Valencia), E. Saridakis (N.O. Athens), S. Sarkar (Oxford U.), E. Tsesmelis (CERN), G. Zanderighi (CERN & Oxford U.), G. Zoupanos (NTU Athens).

The fourth event, **Workshop on Quantum Gravity, Strings and the Swampland**, took place from 3 to 9 September 2024. It was co-organized and supported by:

- The National Technical University of Athens
- The Municipality of Corfu
- The Ionian University, and
- The Regional Government of the Ionian Islands (Periphery of the Ionian Islands).

It has attracted 55 senior and young scientists; 40 of them have presented their current research project as workshop speakers.

The detailed program of the Workshop can be found at:

<https://physics.ntua.gr/corfu2024/Program/st.pdf>

The Scientific Organizers were:

D. Giataganas (National Sun-yat Sen U), A. Gnechchi (INFN, Padova), A. Kehagias (NTU Athens), D. Lüst (LMU & Max Planck Inst), H. Partouche (Ecole Polytechnique), J. Rosseel (U Wien), N. Toumbas (U Cyprus).

The fifth event, **The Dark Side of the Universe, DSU2024** took place from 8 to 14 September 2024. It was organized and supported by:

- The National Technical University of Athens
- The National Observatory of Athens
- The Ionian University
- The Municipality of Corfu
- The Regional Government of the Ionian Islands (Periphery of the Ionian Islands).

It has attracted 110 senior scientists; 100 of them have presented their current research project as workshop speakers.

The detailed program of the Workshop can be found at:

<https://physics.ntua.gr/corfu2024/Program/ds.pdf>

The Scientific Organizers were:

K. Anagnostopoulos (NTU Athens), V. Keus (DIAS, Dublin), G. Leontaris (U Ioannina), E. Saridakis (National Observatory of Athens), N. Toumbas (U Cyprus), G. Zoupanos (NTU Athens)

The sixth event, **Workshop on Noncommutative and generalized geometry in string theory, gauge theory and related physical models**, took place from 17 to 24 September 2024.

It was co-organized and supported by:

- The National Technical University of Athens
- The Ionian University
- The Municipality of Corfu
- The Regional Government of the Ionian Islands (Periphery of the Ionian Islands)

It has attracted 68 senior and young scientists; 55 of them have presented their current research project as workshop speakers.

The detailed program of the Workshop can be found at:

<https://physics.ntua.gr/corfu2024/Program/nc.pdf>

The Scientific Organizers were:

K. Anagnostopoulos (NTU Athens), P. Aschieri (U. Piemonte Orientale), A. Chatzistavrakidis (Bošković Inst.), G. Fiore (U. Napoli Federico II), H. Kawai (National Taiwan University), J. Nishimura (KEK & SOKENDAI Tsukuba), D. O'Connor (Dublin Instit Adv Studies), R. Szabo (Heriot-Watt), P. Vitale (INFN, Napoli & U. Napoli Federico II), S. Watamura (Tokohu U.), G. Zoupanos (NTU Athens).

The seventh event, ***International Atmospheric Circulation Reconstructions over the Earth (ACRE) Drought and Flood Conference***, took place from 23 to 27 September 2023. It was supported by:

- The National Technical University of Athens
- The Ionian University
- The Municipality of Corfu
- The Regional Government of the Ionian Islands (Periphery of the Ionian Islands)
- The International Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative
- The World Meteorological Organization
- The The Mariolopoulos-Kanaginis Foundation for the Environmental Sciences

It has attracted 30 senior scientists; 28 of them have presented their current research project as workshop speakers.

The detailed program of the Workshop can be found at:

<https://physics.ntua.gr/corfu2024/Program/ac.pdf>

The Scientific Organizers were:

R. Allan (Int. ACRE Initiative), G. Compo (U Colorado CIRES), J. Luterbacher (World Meteorological Org.), R. Stefanski (World Meteorological Org.), R. Stone (Speedbird Climate Pty Ltd & WMO)

The outcome was indeed very impressive, given that the sessions gathered 485 registrations in total. In short, internationally leading scientists have been gathered to participate in the School and Workshops, giving lectures and creating a unique and stimulating scientific environment for the senior as well as the young scientists.

We sincerely thank everybody who contributed to the success of CORFU2024, in particular the young students that came a long way from many different countries. Special thanks are due to all speakers and the organizers, the conference secretary Mrs. Ifigenia Moraiti and the group of our graduate students who helped in various ways and contributed in a very significant manner to the success of the meeting. Finally, we wish to express our gratitude to our sponsors whose financial contribution made it all possible.

They were:

1. National Technical University of Athens
2. School of Applied Mathematical and Physical Sciences (SAMPS)
3. National Observatory of Athens
4. Municipality of Corfu

5. Region of Ionian Islands
6. Ionian University
7. OTE: National Telecommunication Company
8. CERN
9. Deutsches Elektronen-Synchrotron (DESY)
10. Max Planck Institute for Physics
11. Max Planck Institute for Gravitational Physics (Albert Einstein Institute)
12. Sommerfeld Center for Theoretical Physics
13. National Center of Scientific Research "Demokritos"
14. Athens University
15. SISSA: Scuola Internazionale Superiore di Studi Avanzati
16. ICTP: The Abdus Salam International Centre for Theoretical Physics
17. IPPP Durham: Institute for Particle Physics Phenomenology
18. LAPP: Laboratoire d'Annecy – le - Vieux de Physique des Particules
19. LAPTH: Laboratoire d'Annecy – le - Vieux de Physique Theorique
20. LPTENS: Laboratoire de physique théorique ENS
21. Universidad Autonoma de Madrid
22. Instituto de Fisica Teorica UAM/CSIC
23. Uppsala University
24. University of Warsaw
25. University of Granada
26. Technical University of Lisbon
27. IFIC Valencia
28. Oxford University
29. Universidad Autonoma de Madrid
30. Scuola Normale Superiore, Pisa
31. NCSR "Demokritos"
32. ITP Heidelberg
33. CPHT, Ecole Polytechnique
34. Queen Mary University of London
35. Rudjer Bošković Institute Zagreb
36. Swansea University
37. Turin University
38. Ephorate of Antiquities of Corfu
39. The International Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative

40. The World Meteorological Organization
41. The The Mariolopoulos-Kanaginis Foundation for the Environmental Sciences

The Editors

Allan, Rob (Int. ACRE Initiative)
Anagnostopoulos, Konstantinos (NTU Athens)
Aschieri, Paolo (U Piemonte Orientale & INFN Torino)
Chatzistavrakidis, Athanasios (Ruđer Bošković Institute)
Compo, Gilbert P. (U Colorado CIRES, NOAA Phys Sci Lab)
Di Valentino, Eleonora (U Sheffield)
Giatagnas, Dimitrios (National Sun Yat-sen University)
Gnecchi, Alessandra (INFN, Padova)
Kalinowski, Jan (U Warsaw)
Kehagias, Alexandros (NTU Athens)
Keus, Venus (Dublin Inst Adv Studies)
Kordas, Konstantinos (Aristotle U Thessaloniki)
Kortner, Oliver (Max Planck Inst. für Physik)
Leontaris, George (U Ioannina)
Levi Said, Jackson (U Malta)
Nishimura, Jun (KEK & SOKENDAI)
Patellis, Gregory (IST-ID, U Lisboa)
Rebelo, Margarida Nesbitt (IST, U Lisboa)
Rosseel, Jan (Ruđer Bošković Institute)
Saridakis, Emmanuel (National Observatory of Athens)
Simon, Frank (KIT)
Slonosky, Victoria (McGill U/Open Data Rescue)
Stone, Roger (Speedbird Climate Pty Ltd & WMO)
Torre, Riccardo (INFN, Genova)
Toumbas, Nikolaos (U Cyprus)
You, Tiann Tevong (CERN)
Vitale, Patrizia (U. Napoli & INFN)
Zoupanos, George (NTU Athens)