# Executive summary

of the virtual YOUNGST@RS MITP Event

## Supergravity and Holography Workshop 2021

## SUGRHOW-21

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organized by

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The unification of quantum principles with gravity into a consistent theory of quantum gravity is one of the main challenges of modern theoretical physics. In this context, several approaches based on different motivations and techniques have been developed. Among them, **supergravity** and string theory turned out to be complementary approaches to quantum gravity. The former, being a **low-energy effective theory for the massless excitations of superstring theory**, is realized as a supersymmetric extension of general relativity, where invariance under general coordinate transformations follows from supersymmetry itself. In this scenario, it becomes of crucial importance to single out the essential features shared by different approaches which may then benefit from the mutual interchange of tools and ideas. In this respect, one of the major recent development concerns the **holographic principle**, of which one of the most celebrated realizations is the **AdS/CFT correspondence** (also known as **gauge/gravity duality**). The holographic principle was originally motivated by **black hole** physics and in particular by the peculiar property of their entropy scaling with the horizon area rather than with their volume, as one would instead expect being entropy an extensive quantity. It is widely expected that any good candidate quantum gravity theory should exhibit holographic features, at least in certain regimes. Although under the experimental point of view holography is still a hypothetical perspective, the study of holographic aspects of supergravity theories is a promising framework for connecting different approaches as well as for understanding to which extent holography might be realized at a fundamental level.

The three-days virtual workshop SUGRHOW-21 brought together a diverse group of leading theorists in **supergravity, black hole solutions, and holography**, forging collaborations between different areas and setting the agenda for future developments and new application. We were privileged to have prominent experts in these fields participate in the program, ensuring top-quality research output, with significant impact on several sub-fields. The key focus areas were unconventional supersymmetry, recent advances in supergravity and applications in the context of holography, teleparallel supergravity, geometric approaches to supergravity in superspace, regularization methods in gravity, and black hole solutions, but the scope of the workshop went way beyond and encompassed a broad vision of several fields of research, especially in the discussion sessions (which were moderated by the organizers).

The workshop involved **6 talks** (2 talks per day, for 3 consecutive days) of 55 minutes each (plus 5 minutes for questions) on a wide range of topics relevant in the context of supergravity and holography. We succeeded in bringing together researchers with expertise in **supergravity models,**

**geometric approaches to theories of gravity and holography techniques**, to explore in detail and overcome the frontiers of the gauge/gravity duality and its applications under the gravitational perspective, in a **very fruitful collaborative environment. Each daily set of presentations was followed by a 1-hour discussion panel.** The time allocated to talks and discussions was well balanced, allowing to the presenter to cover the respective topic in-depth, yet leaving time for a vivid discussion. This MITP Virtual Workshop had a light schedule with only two talks per day in order to stimulate collaborations and informal discussions among the participants. This was in fact achieved by long discussion sessions and informal chats between the participants. On average, we have seen 25 participants online. The workshop was targeted to both young and senior researchers in the field of high energy physics, and in particular in the research areas of supergravity and holography.

The **first day** started with a Welcome Greeting by MITP Directors. After that, we had the first talk by Jorge Zanelli (Centro de Estudios Científicos, Valdivia, Chile), entitled "Local SUSY, and unconventional approach", followed by the second talk, given by Laura Andrianopoli (Politecnico di Torino, Torino, Italy) and entitled "Unconventional supersymmetry and $AdS_4$ supergravity". The scientific program of the day was devoted to unconventional supersymmetry and its relation with $AdS_4$ supergravity, in the direction of applications within the holographic setup.

The **second day** started with the talk of Evelyn Rodríguez (Instituto de Matemática, Universidad de Talca, Talca, Chile), entitled "Chern-Simons Supergravity theories with torsion and non-relativistic limit", and continued with the presentation of Pietro Antonio Grassi (Università del Piemonte Orientale, Alessandria, Italy), entitled "The integral forms for the geometry of supergravity". The program of the second day was focused on teleparallel supergravity in the Chern-Simons formulation, on the study of its non-relativistic limit, and on a powerful geometric formalism (integral forms formalism) for supergravity in superspace.

The **third day** covered conformal renormalization in AdS gravity and recent developments on black hole solutions with unbroken supersymmetries in Einstein-Gauss-Bonnet supergravity. The first talk of the day, entitled "Conformal renormalization in AdS gravity" was given by Rodrigo Olea (Universidad Andrés Bello, Santiago, Chile). Subsequently, we had the second talk of the day, given by Olivera Mišković (Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile) and entitled "EGB supergravity and black holes with unbroken supersymmetries".

In retrospect, the very successful virtual YOUNGST@RS MITP event "Supergravity and Holography Workshop 2021" served the extremely important task of bringing together supergravity and holography experts from various universities all over the world, giving the possibility of connecting and discussing with other fellow colleagues, vital aspect of research, despite the Covid-19 pandemic. SUGRHOW-21 was of **international reach** and gave the opportunity to strengthen and consolidate the mutual experience in the research fields that were addressed, offering an **environment open to collaboration** since day one. The program allowed the participants to **learn, work, and discuss on frontier topics and methodologies in high energy physics**, especially regarding supergravity and holography.

We made our goal to organize a workshop where **equal opportunities and gender balance were strongly promoted**, encouraging women researchers and minority scientists to participate.

Further details and material (poster of the event, slides and videos of the talks, etc.) can be found at https://indico.mitp.uni-mainz.de/event/287/

Videos of the talks are also available at MITP YOUNGST@RS - Supergravity and Holography - YouTube