Executive Summary of the MITP Scientific Program: "Holography, Generalized Geometry, and Duality"

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Goals of the Scientific Program

The goal of the scientific program was to bring together experts working on diverse but interconnected topics in string theory, supergravity, supersymmetric and conformal field theory, black hole physics, and string phenomenology. The idea was to discuss the many recent advances on the interface of these subjects and to outline new promising avenues and research directions. We are happy to report that our goal was met with enthusiasm by the international research community and the overwhelming majority of invited participants attended the program and contributed to the very active research atmosphere. During the two weeks of the workshop we had 29 research talks of 40 minutes each with two morning and one afternoon talks. This relatively light program was chosen to facilitate an interactive atmosphere in which the research talks lead to active discussions and opportunities for collaboration.

Scientific Highlights of the Scientific Program

As outlined in our original research proposal the program focused on several topics on the interface between holography, generalized geometry and duality. The following research directions formed the backbone of the scientific discussions during the program:

- Recent advances in exceptional field theory and generalized geometry were thoroughly discussed. These methods lead to novel insight about the structure of supersymmetric AdS solutions of ten- and eleven-dimensional supergravity.
- Application of pure spinor techniques to the construction of explicit AdS solutions of string and M-theory. A particular emphasis was put on the relatively

poorly explored but important class of AdS_3 solutions with various amounts of supersymmetry. RG flows in holography, sketched in figure 1, were discussed in various talks.

- A strong emphasis was put on the interplay between exact QFT results from supersymmetric localization and their applications in holography. The particular examples of this rich subject ranged from the physics of black holes and black strings in AdS, through exact evaluation of sphere partition functions, to the holographic dual of Nekrasov's Ω-background. Some of these applications are sketched in Figure 2.
- A plethora of new results in supersymmetric quantum field theory played a prominent role. In addition there were two very interesting talks on the use of generalized global symmetries in various holographic CFT's and the study of supersymmetric gauge theories with discrete gauge groups.
- Applications of F-theory to the study of black holes and in relation with 5d CFTs were reported. This is illustrated in figure 3.
- Several of the leading experts on duality and world sheet techniques presented an overview of recent results in this field. In particular non-Abelian T-duality and various world sheet deformations were discussed. These studies have a fruitful interplay with integrability and holography which was actively discussed. Some intriguing suggestions about possible generalizations of the equations of motion of supergravity were also pointed out.
- There were also several talks on applications of holography, duality and generalized geometry to realistic physical systems. This includes a newly proposed holographic model for cosmology, a careful study of the well-known KKLT mechanism for constructing de Sitter vacua of string theory, as well as a new explicit solution of IIB supergravity dual to a non-conformal four-dimensional gauge theory.

Open problems and Conclusions

The following conclusions were reached through the scientific discussions during the workshop:

• Applications of exceptional and generalized geometry methods were used to shed light on how and why consistent truncations to lower-dimensional gauged supergravity arise. These advances confirmed the relevance and importance of

these methods for the study of supergravity theories in particular in a holographic context.

- Breakthrough advances on the applications of exact techniques such as localization to the study of Black Hole physics were reported. These provided convincing evidence of the far reaching applications of these methods to the microscopical description of black holes.
- Worldsheet techniques based on dualities and integrability were applied to holography and important open problems such as the realization of so-called generalized supergravities in the context of string theory were reported.
- Advances in supersymmetric five-dimensional CFTs and their interplay with holography, as well as anomaly polynomial techniques for studying M5-branes wrapped on curved manifolds were reported, followed by a description of systems were these techniques can provide important further insight.

In addition to the diverse program of scientific talks presented at the workshop many of the participants, for example Malek, Pando-Zayas, Schäfter-Nameki, Sfetsos, informed us that they had numerous productive discussions and some of them have lead to new collaborations. For instance, Malek and Uhlemann initiated a study of consistent truncations for globally regular AdS₆ solutions of IIB supergravity. The development of a general framework for consistent truncations of tenand eleven-dimensional supergravity to five-dimensional $\mathcal{N} = 2$ gauged supergravity was started by Malek, Petrini, and Waldram. In addition Malek and Thompson began working on a generalization of Poisson-Lie duality to eleven-dimensional supergravity. Lozano and Núñez started a collaboration with Macpherson on AdS₃ supergravity solutions.

We received several very positive comments from the participants about the organization, format and schedule of the program. The participants also appreciated the provided office and discussion space and in particular the two offices dedicated for discussions and Skype conversations.

This scientific program benefited greatly from the support provided by the MITP director and the staff of the institute. All organizers and participants are grateful for the administrative, logistical, and scientific support which resulted in a very relaxed atmosphere with plenty of opportunity for scientific interactions.

Holography of RG flows across dimensions

According to AdS/CFT [Maldacena-Núñez]



Extremal black $p\mbox{-branes}$ in asymptotically locally AdS are flows across dimensions!

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Three perspectives

1) Reduction on S^3 : A-model on $\Sigma_{\mathfrak{g}}$



2) Reduction on $\Sigma_{\mathfrak{g}}$: Direct sum of 3d theories



3) Uplift from 4d: Nekrasov partition function: $Z_{S^3 \times \Sigma_{\mathfrak{g}}} = \sum_n Z_n^{Nekrasov}$

Black holes in F-theory [Hagighat, Murthy, Vafa, S.V., '15] F-theory on $CY_3 + D3$ (1,0) D=6 SUGRA AdS₃ x S³ (0,4) CFT with SU(2)_L