Preface

This thesis collects thoughts and results that originate from a four-year-long research project in theoretical physics. The main topic is representation theory and its application to quantum gravity, in particular in the context of BMS symmetry. The text consists of three parts:

Part I: Group theory;
Part II: Virasoro symmetry and AdS_3/CFT_2;
Part III: BMS symmetry in three dimensions.

It is written in such a way that each part can be read more or less independently of the others, although the later parts do depend on background material presented in the earlier ones; the logical flow of chapters is explained in Sect. 1.5. A few sections are marked with an asterisk; they contain somewhat more advanced material that may be skipped without affecting the reading of the main track.

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The original contributions of this thesis are based on the following publications:

- G. Barnich and B. Oblak, "Holographic positive energy theorems in three-dimensional gravity," *Class. Quant. Grav.* **31** (2014) 152001, 1403.3835.
- G. Barnich and B. Oblak, "Notes on the BMS group in three dimensions: I. Induced representations," *JHEP* **06** (2014) 129, 1403.5803.
- G. Barnich and B. Oblak, "Notes on the BMS group in three dimensions: II. Coadjoint representation," *JHEP* **03** (2015) 033, 1502.00010.
- B. Oblak, "Characters of the BMS Group in Three Dimensions," *Commun. Math. Phys.* **340** (2015), no. 1, 413–432, 1502.03108.
- G. Barnich, H.A. González, A. Maloney, and B. Oblak, "One-loop partition function of three-dimensional flat gravity," *JHEP* **04** (2015) 178, 1502.06185.
- B. Oblak, "From the Lorentz Group to the Celestial Sphere," *Notes de la Septième BSSM*, U.L.B. (2015). 1508.00920.
- A. Campoleoni, H.A. González, B. Oblak, and M. Riegler, "Rotating Higher Spin Partition Functions and Extended BMS Symmetries," *JHEP* **04** (2016) 034, 1512.03353.
- H. Afshar, S. Detournay, D. Grumiller, and B. Oblak, "Near-Horizon Geometry and Warped Conformal Symmetry," *JHEP* **03** (2016) 187, 1512.08233.
- A. Campoleoni, H.A. González, B. Oblak, and M. Riegler, "BMS Modules in Three Dimensions," *Int. J. Mod. Phys.* **A31** (2016), no. 12, 1650068, 1603.03812.

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