The so called AdS/CFT correspondence posits that certain quantum field theories (conformal quantum field theories or short CFTs) can be described in a mathematically equivalent but dual way in terms of gravitational theories involving a negative cosmological constant, i.e. a negative overall curvature. This means that this correspondence, or duality, establishes a connection between a theory of matter on a curved spacetime on the one side and a quantum theory of matter fields on flat space on the other side. It is hence a powerful tool that allows to translate questions about one side of the duality into questions about the theory on the other side of the duality, where this question may be easier to solve with the available mathematical methods. This opens up an entirely new perspective on the most fundamental mysteries of modern physics, such as the ultimate nature of space and time, the fate of matter falling into a black hole or the absolute limits on the speed of quantum computers. The AdS/CFT correspondence has hence become one of the most active and fast developing fields of modern theoretical physics over the last two decades.

During this time, extensive study of the AdS/CFT correspondence has revealed several entries into the so called holographic dictionary, an ever increasing list of mathematical quantities on the field theory side together with their dual quantities on the gravity side. Calculating a given quantity in a quantum field theory may be very hard. But if the field theory has a holographic dual, calculating the dual quantity on the gravity side will yield the same result, and may be much easier. Every new entry into the holographic dictionary that is uncovered hence leads to enormous progress of our understanding of the quantities in question.

Two recently investigated new entries into this holographic dictionary seem to indicate that geometrical features of the curved spacetime on the gravity side, such as volumes of certain parts of the spacetime, have a dual interpretation as describing either the complexity of the field theory state, or its fidelity susceptibility. Both these terms come from quantum information theory, and can be interpreted as describing how complex a given state is, with respect to another reference state. Understanding these two new entries into the holographic dictionary better will help to understand the nature of the AdS/CFT correspondence and how it connects gravitational physics, quantum field theory and quantum information theory. Using the full potential of the AdS/CFT correspondence, this will then allow for substantial progress in these fields, form rather theoretic considerations about the nature of black holes to possible applications in the field of quantum information theory, quantum computing, quantum cryptography or nano-technology.

My own preliminary research in this direction has recently revealed that AdS/CFT type models of boundary CFTs (BCFTs), i.e. CFTs defined on a space with a boundary, such as a halfplane, satisfy what I termed a "complexity/fidelity susceptibility analogue" of the so called g-theorem. This g-theorem states that when lowering the temperature, the so called boundary entropy of BCFTs can only decrease. Using AdS/CFT, I showed that, in analogy to this behaviour of the boundary entropy, the complexity and fidelity susceptibility of such models will also decrease as the temperature is lowered. The g-theorem, however, is only one of many similar theorems. More famous, for example, is the so called c-theorem. It is hence a natural question to ask whether this c-theorem and similar monotonicity theorems also have complexity/fidelity susceptibility analogues. While some qualitative arguments may suggest so, this has not been investigated in detail yet. The objective of my research will be to close this gap of knowledge and investigate whether monotonicity theorems for complexity and or fidelity susceptibility can be derived using AdS/CFT methods. The results that may follow from this work will shed new light on the underlying principles of quantum information theory and gravity.