# The Role of Black Holes in the AdS/CFT Correspondence

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The project will initially focus on the foundation of the AdS/CFT correspondence, such as the 't Hooft limit and the important identification between the symmetry groups of the Anti-de Sitter symmetry group and the conformal group. Presumably, the project will focus on the correspondence between the compactified ten dimensional Type IIB string theory and the four dimensional $\mathcal{N} = 4$ Super Yang-Mills conformal field theory. While the perspective of the conformal field theory cannot be neglected when discussing the duality, the focus will primarily be on the gravitational aspect of the correspondence. This approach will involve the study of super string theory (and perhaps M-theory), and noteworthy the inherit supersymmetry. From here the near-horizon geometry of a collection of coinciding branes which is the Anti-de Sitter space arises. Anti-de Sitter space can under some circumstances support black holes, which enables the investigation of the AdS/CFT correspondence at a finite temperature. To understand this in better detail it is necessary to introduce the results of quantum black hole thermodynamics. The thermodynamic properties are also connected to results in string theory where their higher dimensional generalisations known as black branes also originates. Turning on a finite temperature will evidently also enable the investigation of gauge theories without supersymmetry. A first aim for this project will be to understand the phase transition duality of the formation of a black hole in Anti-de Sitter space in the context of quantum gravity studied by Hawking and Page [2] and how this can be viewed as a confinement/deconfinement transition in the corresponding gauge theory. Hereafter, entropy calculations and the dynamical properties of high temperature gauge theories could be a source of further investigation. Further development is left open for the finite temperature correspondence.

**References**


[1] Dr. Sonner, J. (2009). Lecture notes from special topics week.

[2] S. W. Hawking and D. Page. (1983). "Thermodynamics of black holes in anti-de Sitter space"

[3] Aharony, O., Gubser, S. S., Maldacena, J. M., Ooguri, H., and Oz, Y. (2000). "Large N field theories, string theory and gravity".

[4] E. Witten. (1998). "Anti-de Sitter space, thermal phase transition, and confinement in gauge theories".