SL(2,C) Chern-Simons Theory and Quantum Gravity with a Cosmological Constant[1] HAL HAGGARD, Physics Program, Bard College, MUXIN HAN, Institute for Quantum Gravity, University of Erlangen-Nurnberg, WOJCIECH KAMINSKI, Instytut Fizyki Teoretycznej, Uniwersytet Warszawski, ALDO RIELLO, Perimeter Institute for Theoretical Physics — We show a relation between 4-dimensional quantum gravity with a cosmological constant and SL(2,C) Chern-Simons theory in 3-dimensions with knotted graph defects. In particular, we study the expectation value of a non-planar Wilson graph operator in SL(2,C) Chern-Simons theory on S^3. We analyze its asymptotic behavior in the double-scaling limit in which both the representation labels and the Chern-Simons coupling are taken to be large, but with fixed ratio. We find that a class of flat connections in the graph complement manifold are in correspondence with the geometries of constant curvature 4-simplices. We show that the asymptotic behavior of the amplitude contains an oscillatory part proportional to the Regge action for the single 4-simplex in the presence of a cosmological constant. In particular, the cosmological term contains the full-fledged curved volume of the 4-simplex. Interestingly, the volume term stems from the asymptotics of the Chern-Simons action. Another peculiarity of our approach is that the sign of the curvature of the reconstructed geometry, and hence of the cosmological constant in the Regge action, is not fixed a priori, but rather emerges semiclassically and dynamically from the solution of the equations of motion.

Hal Haggard
Bard College

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