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Geometries of quantum systems: Towards an AdS / Quantum Mechanics correspondence

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Abstract content
   (Max 300 words)

The tools necessary to build up a geometric manifold from a basis for a Hilbert space have been developed some time ago. By using a basis labelled by a continuous parameter (a coherent basis of n complex parameters for instance) one recovers the metric of a 2n-dimensional Riemannian manifold. By using coherent states augmented by a Boltzman weight a metric for a 2n+1-dimensional Riemannian manifold that also encodes the dynamics can be constructed.

As an example we investigate SU(2) coherent states augmented by the Boltman weight for the Lipkin model, a toy model for two nuclear shell interactions. The Lipkin model is known to exhibit a quantum phase transition at a critical value for the coupling constant. It exhibits two phases, the first for coupling constants smaller than the critical value and the second for larger coupling constants. We reach the thermodynamic limit by performing a group contraction on SU(2) and write down the corresponding group contracted Lipkin Hamiltonian for the first phase.

We show further that the first phase Lipkin model, in the thermodynamic limit, at the critical point and near the zero temperature limit produces a Riemannian metric that satisfies the Einstein field equations with a cosmological constant. Specifically, the energy-momentum tensor is zero, implying a vacuum solution. Furthermore it is shown that the solution of these field equations is, in fact, Anti de Sitter as the cosmological constant is negative.

Lastly, we consider finite small temperature corrections and small perturbations from the critical point. In this case the energy-momentum tensor is non-vanishing, but, at least in some cases, the Einstein field equations can still be solved.

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Level for award
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PhD

Main supervisor (name and email)
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