Questions – Black hole thermodynamics in AdS_5

March 18, 2016

1. What does he mean when he says that the path integral on a circle defines a thermal state? To define a state from a path integral we need to keep one of the boundary conditions free but if we integrate on a circle for time there is no boundary condition left since the only one is periodicity. He can't also mean the thermal density matrix because then we need to keep both boundary conditions free.

2. Is the only difference between preparing a thermal state and a regular state using path integral that time is periodic or not? Because even for regular states we use the Euclidean path integral.

3. Should the boundary condition on the metric be that it is in the conformal class of M instead of just M?

4. Why do we turn off all the fields other than the metric to compute the free energy? Wouldn't they contribute?

5. What is the conical defect trick?($\times 3$) How do the boundary conditions fix β? How to get equation 16.11?

6. End of first paragraph p. 146: Isn't ℓ AdS radius? If so, aren't all black holes very small?

7. About the statement that an ordinary Schwarzschild black hole is thermodynamically unstable, can we interpret this by saying that a Schwarzschild black hole in Minkowski spacetime cannot be in a Hartle-Hawking state, only in a Unruh state? And then, if the black hole is in AdS, it sort of has reflecting boundary conditions which allows for thermodynamical equilibrium, is that right?

8. Does anybody know the behaviour of the radius of a dS-Schwarzild black hole with temperature? (Analogue of 16.12) Specific heat in that case?

9. Does the counter term in the gravitational action have the same meaning as it did when we studies it before?

10. What is the intuition for the dominant solution, the one with lower free energy, being the larger black hole as opposed to the smaller black hole?

11. re: the comments below equation 16.16 . Are there other classical solutions which obey the thermal bdy conditions? For example, what about multi-black hole, or multi-centered black hole, solutions? My guess would be

that the more complicated BH solutions would dominate the dynamics at high energy.

Similarly, do there exist vacuum solutions to Einstein's equations that are not spherically symmetric?

12. Coming back to something about a previous discussion: we said that light operators in the CFT are dual to light fields in the bulk (they couple like we saw before in the action) and heavy ones are dual to black hole states so is there a way of computing correlators of heavy operators using the bulk?

13. If our world was AdS, what would be the cosmological observations for a H-P phase transition (transition from BHs to empty AdS as the temperature cools down)?

14. What happens to β_{crit} if we include onle-loop determinant corrections to the two actions (BH and thermal AdS)?

15. *"This phase transition is called the Hawking-Page transition and was discovered well before AdS/CFT. The story is qualitatively the same in any number of dimensions, AdS_{d+1} (with a few differences in AdS_3)."*Can anybody comment about the the AdS_3 case?

16. How is it that he says that the computation corresponds to a CFT on a sphere of radius L? I see the sphere, but not the finite radius.

17. Can we explain a bit the comments on page 147 about the thermal AdS circle, specifically, that "there is no origin". Why in thermal AdS does the circle associated with $t_E \sim t_E + \beta$ not contract anywhere? Can someone draw the picture? Discussion of *contractible-noncontractible* time circle issue and connection with the Wilson lines (+ What is a Wilson loop/line?).

18. The H-P phase transition is a transition between phases that has to do with the exchange of dominance of two classical solutions. Are there any other examples in other spacetimes that this transition happens? (e.g. in dS i guess it's also true, between thermal dS and a dS BH, right?). Also, the exchange of dominance in this example has to do with the classical contributions to the partition function. Is there any example that exchange of dominance starts to happen in the one loop order(and e.g. is not apparent in the classical terms)?