Quantum Gravity and Black Holes: Questions on Lecture 8 and 10

February 12, 2016

1 Lecture 7

1. When he says late time, does he mean right now or the end of inflation?

2 Lecture 8

1. Reminder of where the boundary term in (8.14) came from. Reminder of Gibbons-Hawking term. How general is this? Do we have same boundary terms in Yang-Mills?
2. Physical intuition one should have behind the phrase: "Gauge symmetries are just convenient human invention to describe massless particles
3. Where does equation E.2.42 in Wald come from? (or more simple E.2.37)
4. Can someone clarify the steps in writing the Hamiltonian of GR? Specifically what has to be fixed when and what depends on what? For example do we fix the lapse and shift at the beginning? And is this related to the fixing of the time coordinate in the metric?
5. How do we relate one slicing to another one?
6. Is there a relation between fixing the lapse and the shift and fixing the gauge?
7. The fact that the lapse and shift are not dynamical means that some DoF in the metric are redundant I think but is there an analogue in the Lagrangian formalism or it comes from the fact that time has a special role here?
8. Could we define the energy with respect to a different time in section 8.2 and have another expression that is conserved in this time or we need to start from the beginning with this other slicing?
9. If GR is not invariant under diffs that reach infinity, why does he say that they are symmetries?
10. Can we talk again about why diffeomorphisms acting on the boundary are 'real' dynamics?
11. The EM Hamiltonian has a local energy density term plus constraint plus surface (in general). GR Hamiltonian has only constraint plus bdy terms. Is there a general 1/N suppression of the local energy density terms in Yang Mills theories?
12. If I understand correctly a spacetime doesn't need to be time independent everywhere but only at infinity to have an energy that is conserved?
13. Compact spacetimes do not have asymptotic symmetry groups right? (because bdy=0) Can we say that?
14. I guess this is related to another of my questions but if we look at the example do we implicitly know the lapse and shift from the shape of the metric or we just don't care about them?
15. (Based on Note 50 pg.89) What determines whether the infinity is spacelike,timelike or null? The metric, when expand around 1/r? Simple example?

16. (Based on 8.41 and the central charge comment) How the central extensions enter in general plus reminder of the central extension of Galilean group where the central charge is the mass (Alex's comment from last years course)