20 BLACK HOLE QUESTIONS

Jan de Boer, Amsterdam

ICTS, May 29, 2018

DISCLAIMER:

- Highly biased set
- Highly asymmetric set
- Not ordered according to importance of chronology
- Lack of references
- 20 questions is perhaps a bit of a stretch

Question #1: How does information get out?

In what way does effective field theory break down? Or should we never have applied it to nice slices to begin with?

Question #2: What happens to the infalling observer?

Usual debate is between "nothing" and "firewall".

In BPS case there are multi-centered solutions, wall-crossing phenomena, etc, Important for precision counting.

Question #4: Which (meta)stable black holes with non-spherical horizon topology exist?

Famous example: supersymmetric black ring; Gregory-Laflamme instabilities; Classification of possible horizon-topology

In free field theory partition function overcounts and index undercounts.

Question #6: What does complexity teach us about black holes?

What is complexity anyway?

Question #7: Which general principles follow from the existence and consistency of (extremal) black holes?

For example, global symmetries are gauged, the weak gravity conjecture (existence of superextremal particles), instability of non-susy vacua

Question #8: Can we experimentally hope to see signs of quantum gravity effects near black holes in the near future, e.g. with LIGO/VIRGO or the EHT?

I am not very optimistic

Question #9: If we need state-dependent operators to study the black hole interior, can this formalism be extended to the most general situation (including e.g. collapsing black holes)?

Cf Papadodimas-Raju

There is no way to decouple the near-horizon region so any computation always includes part of the thermal atmosphere? Logarithmic corrections are still ok?

Question #11: Make ER=EPR more precise

What happens for large but non-maximal entanglement?
For multi-partite entanglement? Can we prove something?
Conversely, do baby-wormholes produce entanglement?

Question #12: Is there an interesting dynamical AdS2/CFT1 correspondence?

AdS2 tends to be unstable to perturbations (fragmentation). AdS2 is just a geometric representation of a set of ground states? Why is there no obvious decoupling limit in CFT2?

Question #13: Proof directly that the string theory partition function for BPS black holes is an integer

Localization?

Not dual to a standard ensemble, why is this a hard question?

Question #15: What happens when the open string metric is that of a black hole but the closed string metric is not? Which aspects of black holes carry through?

Scrambling, chaos, ER=EPR, .. Entropy?

Question #16: Do black holes have soft hair that an observer near the black hole can detect?

Not obvious in current constructions of soft hair

Question #17: What role do fuzzballs play in black hole physics?

Long story..

Question #18: What is the interpretation of entanglement shadows near black holes?

Is there any qualitative change in the CFT description of local operators there?

Question #19: Can we derive state of the art fluid effective actions directly from black hole geometries?

Seems to be possible..

Question #20: What is the dual of a pure state?

Cf talk by Kyriakos last week…

Conclusion:

We are not done yet!!!!