The fuzzball proposal for black holes

Riccardo Banzi

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Theoretical Problems

- Information paradox
- Microstate problem

Black holes can be assigned an entropy $S = \frac{A_{hor}}{4G}$

Corresponding microstates: $e^{\frac{S}{k_b}}$. Huge number.

Microstates correspond to metrics: due to the no hair theorem there is only one metric!

The fuzzball conjecture

Both GR and QM are involved, therefore we can try to solve the problem by using String Theory.

$$\rightarrow \text{Fuzzball conjecture (Mathur,2002)}$$

Fuzzballs are solutions that describe black holes in String Theory.

Structure of the fuzzball

The inner region of black holes is replaced by a ball of strings of radius R_S, with no event horizon.

- $r > R_S$: Objects that are far from the surface are affected in the same way as with the classical model of the black holes.
- $r < R_S$: We begin to observe stringy behaviours. In this region we have different metrics corresponding to different vibration profiles of the strings. These metrics describe different microstates!

AdS/CFT

Only a restricted set of microstates is explicitly known. The aim of my thesis was to find new metrics.

The AdS/CFT correspondence plays a major role. In the near horizon limit the spacetime contains an AdS_3 factor, therefore we can work with a 2 dimensional CFT instead.

The CFT is weakly coupled, therefore the calculations are way more menageable.

My contribution

New solutions can be found by applying diffeomorphisms on a known metric, representing $AdS_3 \times S_3 \times T_4$.

On the CFT side, this corresponds to applying operators to the state corresponding to $AdS_3 \times S_3 \times T_4$.

By using this method, I could find new microstates. The next step consists in generalizing my results in order to obtain microstates that cannot be obtained with this method.

Future Developments

Open problems:

- In what microstates are black holes typically found?
- When do fuzzballs produce observable deviations from a typical black hole?

Thank you for your attention!