ID de Contribution: **93** Type: **Non spécifié**

Holography of time machines

We use holography to examine the response of interacting quantum fields to the appearance of closed time-like curves in a dynamically evolving background that initially does not contain them. For this purpose, we study a family of two-dimensional spacetimes that model very broad classes of wormhole time machines. The behavior of strongly coupled conformal theories in these spacetimes is then holographically described by three-dimensional AdS bulk geometries that we explicitly construct. The dual bulk spacetime is free from any divergences, but splits into two disconnected components, without and with CTCs, which are joined only through the boundary; then, passages across the chronology horizon are impossible for any field excitations. In dual terms, the strong self-interaction of the CFT suffices to enforce – without any gravitational backreaction – the chronology protection principle in the most explicit manner: by completely decoupling the pathological part from the rest of the spacetime. We also find that entangling the CFTs in two separate time machines connects them through a traversable bulk wormhole. Nevertheless, any entanglement-assisted chronology violations will be prevented by quantum bulk corrections, i.e., subleading 1/N effects, again without needing any gravitational backreaction of the CFT.

Type of contribution

Contributed Talk or Poster

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Classification de Session: Posters

Classification de thématique: Posters