Compactness and Observers: Consideration of Implications

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Abstract

In this note the authors utilize the Heine-Borel theorem to deduce that every group of observers of the Earth's region in the solar system might have a finite subgroup that is also capable of observing the entire region. Effectively this means that a finite number of extra-terrestrials might be able to oversee the entire Earth. By extending this result, they propose that there might be a lot of activity within singularities such as black holes, under the assumption of topological non-compactness.

As per the Heine-Borel theorem [1] every closed and bounded subset of the reals is compact. Consider the spatio-temporal region occupied by the Earth. Clearly, it is closed and bounded as a subset of the universal spacetime manifold. Thus every covering of it will have a finite subcover that also covers it. Thus a finite group of entities, as few as a single entity, might be sufficient to "cover" or observe the Earth. By extrapolation, this holds for any compact section of spacetime.

In relation to this, consider a blackhole, or the big bang itself. These regions contain singularities which we assume may not be compact topologically. Thus the above conclusion might not apply to the big bang or to black holes. Suppose it doesn't apply. This leaves the door open for the following speculation. Assume an infinite set of observers is required to "cover" the singularity of a blackhole. At the same time note that even light cannot escape the blackhole. This latter fact leads to the consideration that physical observers can't directly observe a blackhole. So, whereas an infinite set may be required, no physical set can be a subset of it.

Further consider how time behaves within a black hole - it doesn't flow as outside. Thus a region requiring an infinite observational overlap to cover it also has the property that any one of those observers may not have any temporal extent. A non-physical, non-temporal infinite set of observers is thus required to observe a singularity. This strange class of observers, when they sample the singularity, would acquire what is to them an infinite amount of information because of zero spatiotemporal extent[1].

[1]This is based on the observation that sampling an environment creates a perception of

Coming back to a compact region of spacetime, we note that this sampling does not alter the environment and secondly, alters the perception of the condition of the environment - it appears to change. This was discussed in [2]. However, for non-physical, non-temporal observers of singularities, we might need to flip the reasoning. Thus these observers might alter the singularity and leave its perception unchanged. Thus we may propose that there might be a lot of "activity" within a singularity (specifically, activity enough to generate an infinite amount of information), without altering its singular nature, as it appears to "us" outside of it. Thus new universes may be being birthed within each singularity.

The present paper seems to have consequences for the black hole information paradox as well. In future work, we hope to make the paper more rigorous using tools from general relativity such as conformal transformations. The works [3, 4] and references therein are particularly important.

References

[1] Halsey Royden and Patrick Michael Fitzpatrick. *Real analysis.* China Machine Press, 2010.

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[3] Gregory J Galloway, Kristin Schleich, Donald M Witt, and E Woolgar. Topological censorship and higher genus black holes. *Physical Review D*, 60(10):104039, 1999.

[4] Quentin Bonnefoy, Luca Ciambelli, Dieter Lüst, and Severin Lüst. Infinite black hole entropies at infinite distances and tower of states. *Nuclear Physics B*, 958:115112, 2020.

space extent and time duration which is inversely proportional to the amount of change found in the environment.