
Thoughts About The Arrow of Time and Cardinality of State Space

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Consider two material observers. They can use photons to synchronize their local clocks, no matter the state of the universe around them. Consider the observers in a material where all photons travel below the speed of light. Assume the observers are massive enough such that emitting some small number of photons does not change their velocities relative to each other. Now observer one travels to the right with a velocity $(1 - \epsilon^2)c$. Observer two travels right as well, with a speed $(1 - \epsilon^3)c$. While traveling right observer two emits photons traveling right with velocity $(1 - \epsilon)c$ in the medium. Clearly the photons are slower than observer one, and will eventually be absorbed by observer one, allowing observer one to count these photons, and if they have different frequencies, their ordering. Since the last photon to be emitted by observer two will be observed first by observer one, observer one may assume that its time variable flows opposite of observer two, this destroys the causal arrow of time. To resolve this, the observers must be able to find some photon that is not impeded by the medium, and travels as if it is in vacuum, so that the observers cannot catch up to time synchronizing photons. For this to be possible, the configuration space of excitations/interactions of the medium must be smaller than the configuration space of possible photons, otherwise I can cook up some medium that interacts any photon conceivable, and slows it, giving the observers no way to determine they share a common arrow of time. One may ask, how are the observers going to observe these photons or emit them, if the supposedly elude interaction with any material. The solution to this fault is gravitational red shift or blue shift. We can have the observers emit photons, and have the gravitationally shifted such that they no longer interact, then they can be shifted back to be observed and used to synchronize time, once observer one has had time to catch up. If photon energies are allowed to continuously vary, then the mathematical space that has a lower cardinality than the real numbers is the integers. I have been informed by a fellow student that the cardinality of Hilbert space appears to be countably infinite, in accordance with being L2 integrable, and I assume photons can have any energy described by a real value. If the photons are to be transformed into some non interacting state outside of the Hilbert space of interaction configurations for matter, the interaction between them and gravitational redshift cannot be of a countably infinite nature, otherwise photons generated by observers could only be manipulated into being part of a different countably infinite set of energies, which again I could cook up a medium who interacts these energies, breaking the arrow of time.