The Arrow of Time, Again!

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The wineglass shattering to the ground never reassembles itself back onto the table, or does it?

Set aside the various definitions and philosophical concepts of "time" [1], I briefly discuss the problem of the "arrow of time" [2]. Simply put, the arrow of time is a concept describing the fact that most physical laws are time-symmetric, i.e. the parameter *t*, time, can just as well flow backwards as forward. However, we never experience events occurring in reverse. Our experience of time appears to go in only one direction, the future, whereas the pertaining equations of physics permit both directions equally, hence the "problem".

This problem is only an apparent problem. As the wineglass is on the verge of falling, the equations predict the eventual shattering of the glass. What has been neglected is that those same equations concurrently dictate our brain activity, data logging and perception of the incident. The equations referred to here are not the select equations applicable to the incident at hand but of the equations of the fundamental laws of physics (or of an eventual Theory of Everything). Restricting the equations solely to the incident mathematically corresponds to performing a local analysis, where boundary and global conditions have been ignored. Such approximations may be valid when confined to the incident. But if the subject of interest is the perceptions (logging) of events then we must examine what the equations say concerning our perceptions and not just to the events themselves. More importantly, if the subject of interest is the temporal order relating two processes then both processes must be analyzed conjointly with the same parameter *t*. The laws do not permit *t* to become negative for some parts while remaining positive for other parts. In the complete picture, the equations not only permit the wineglass to “unshatter” and jump back onto the table, but they also concurrently imply that our logging devices (brain) revert back to a prior state that was devoid of any information about the incident. We have no experience that the event(s) ever occurred and the future will seem as new as the "first time".

The foregoing argument suggests that thermodynamic time (or entropy) will always be experienced only in one direction. For instance, consider figure 1. It represents a mixture of two gasses initially segregated one to each side. Assuming random initial velocities and perfect collisions, the (reversible) equations imply that the gasses will mix (increase in entropy) as a function of time. Here, “time” refers to the *t* in the equations and is physically represented by the value indicated by a clock. In other words, the equations have been constructed by using what the clock indicates as a (evolution) parameter. As the value on the clock increases, the gas mixes as described by the equations, and the degree of this mix is logged. We observed an increase of entropy. However, since the equations are reversible, they imply that the gas can revert back to its segregated state, and in parallel our clock and logging of the process. Entropy can only be logged as an increasing function of (clock) time. We can not observe decrease in entropy since knowledge of such observation has been “erased”.

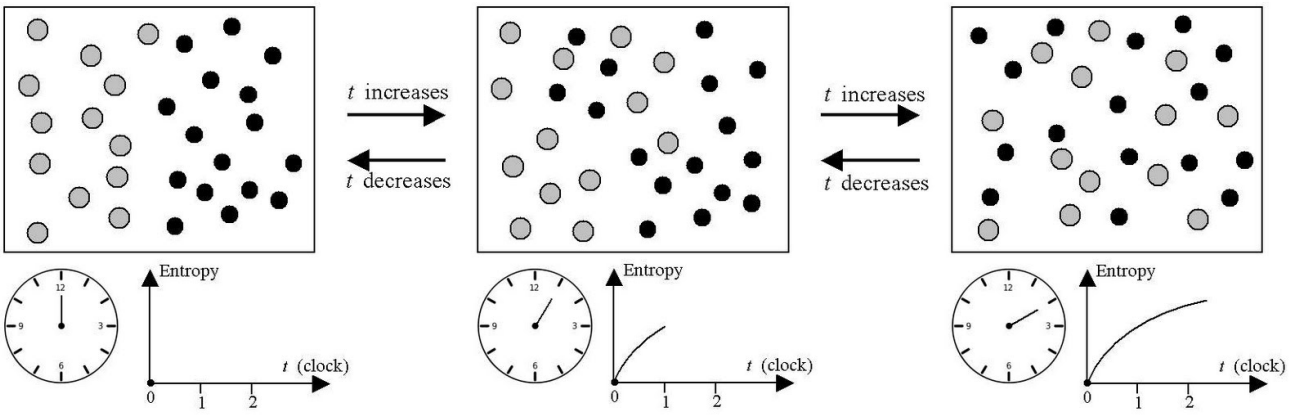

Figure 1. As the value *t* of the clock evolves, the degree of mixing of the gas is logged. In the world of the reversible laws of physics, the logging and experience of phenomena is also reversed. The graph of the entropy is always an increasing function of *t*.

The above argument also applies to the Loschmidt's Paradox [3]. Although it should not be possible to deduce an irreversible process from time-symmetric dynamics, what is possible is that we can only experience irreversible processes.

Whether processes are reversible or not, **when globally analysed, time-reversible laws imply that we can never observe time reversibility.**

This conclusion raises the following possibility. Since the time-reversible equations permit it, perhaps we are continuously going back and forth in time. Sometimes we may have backtracked a few seconds, advanced 20 years or even returned to the early state of the universe! However, we would never have any recollection of such dances. We only remember what is accessed in memory (the past). What we expect or infer is what we call the future. Perhaps our destiny has already been played out, that we have temporarily reverted back in time, but such contemplations shall be done once again over a future glass of wine.

[1]http://en.wikipedia.org/wiki/Time
[2]http://en.wikipedia.org/wiki/Arrow_of_time
[3]http://en.wikipedia.org/wiki/Loschmidt%27s_paradox