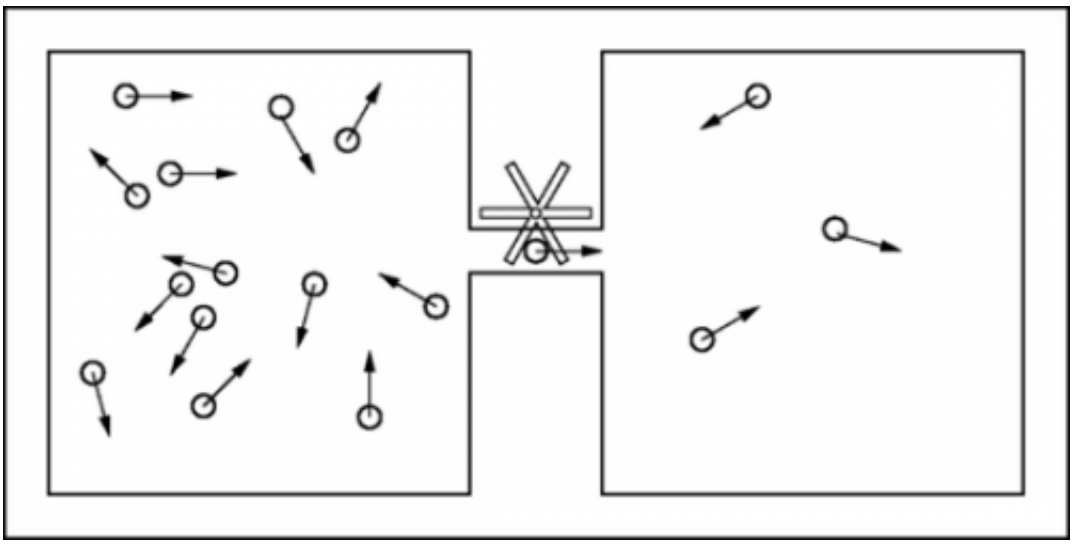
Thought experiment proposed to reconcile psychological versus thermodynamic arrows of time

May 5 2014, by Bob Yirka



A reversible system with a well-defined arrow of time and a memory. Credit: Leonard Mlodinow and Todd A. Brun, *Phys. Rev. E* 89, 052102 (2014)

(Phys.org) —A pair of physicists has proposed a thought experiment to help reconcile the seeming disparity between the psychological and thermodynamic arrows of time. In their paper published in the journal *Physical Review E*, Leonard Mlodinow and Todd Brun claim their thought experiment demonstrates that the two seemingly contradictory views of time, must always align.

When ordinary people think about time, they see the past as something that has come before and the future as a great unknown yet to come. We can remember the past, because it has happened already, but not the future, because it hasn't. Physicists, on the other hand see time as able to move either forward or backwards (towards greater entropy), which implies that we should be able to remember events in the future. So, why can't we?

It's because of the way our memories work the two say, and they've created a thought experiment to demonstrate what they mean. Imagine, they write, two chambers connected by an atomic sized tube with a turnstile in it. If there is gas in one of the chambers, individual atoms of it will move through the tube to the other chamber (towards higher entropy) tripping the turnstile as they go, in effect, counting the atoms as they pass by, until both sides have equal numbers of atoms—creating a state of equilibrium.

The authors contend that such a system represents a memory—the counter on the turnstile can be used to demonstrate prior states of the system. But, they say, it can also be used to view memories of the future, but only in one special case—where nothing causes a change to the system. If at any point, they note, something causes any of the atoms (from the future) to deviate from reversing the exact course they took to return from where they came from, preventing the restoration of the original configuration, then the system will be move from higher entropy to lower. That would suggest that such a memory system, like our own, can only be used as a one way arrow representing time. And that, the authors note, violates the very definition of a memory. The reason we can't remember future events is because we have faulty memories.

More information: Relation between the psychological and thermodynamic arrows of time, Leonard Mlodinow and Todd A. Brun, *Phys. Rev. E* 89, 052102 (2014) Published May 2, 2014

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ABSTRACT

In this paper we lay out an argument that generically the psychological arrow of time should align with the thermodynamic arrow of time where that arrow is well defined. This argument applies to any physical system that can act as a memory, in the sense of preserving a record of the state of some other system. This result follows from two principles: the robustness of the thermodynamic arrow of time to small perturbations in the state, and the principle that a memory should not have to be fine-tuned to match the state of the system being recorded. This argument applies even if the memory system itself is completely reversible and nondissipative. We make the argument with a paradigmatic system, and then formulate it more broadly for any system that can be considered a memory. We illustrate these principles for a few other example systems and compare our criteria to earlier treatments of this problem.