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Comments on Angela Lee's "Statistical Mechanics and the Past Hypothesis"

This paper is a defense of the past hypothesis; i.e. one possible solution to the problems presented by the apparently time asymmetric laws of thermodynamics. The paper begins with a brief account of time asymmetry in thermodynamics, Boltzmann's theory of statistical mechanics, the problems surrounding said theory, and the past hypothesis (one possible solution to Boltzmann's theory).

The second law of thermodynamics, in simplistic terms, states that any irreversible process (e.g. melting ice or a cold hand holding a warm hand until they are the same temperature) results in an increase in entropy. Thus, it is not a time reversal invariant law. In other words, the direction of time is relevant to determining the end result of the relevant process.This is in stark contrast to more fundamental, microscopic laws of physics which are time reversal invariant. Therefore, the following question arises: where exactly does time reversal variance come into the equation? Boltzmann theory of statistical mechanics provides a microscopic account of entropy. However, Boltzmann's account is characterized by time reversal invariance. Therefore, it cannot fully explain thermodynamic time asymmetry, as it cannot make accurate retroactive predictions. One solution to this is the introduction of a boundary condition. By means of the added condition that the universe began in a state of very low entropy, statistical mechanics is enabled to make accurate retroactive predictions. This solution is known as the past hypothesis.

The first objection to the past hypothesis considered by Lee is that there is no independent evidence for the past hypothesis (5-6). Lee responds to this objection by appealing to big bang cosmology. Since contemporary cosmology posits that the universe began in a highly ordered, equilibristic state, cosmological evidence provides independent support of the past hypothesis. One might use big bang cosmology to argue that thermodynamic time asymmetry is located not in dynamic laws but rather in the initial state of the universe. Lee makes the astute observation that such a defense relies on a certain amount of faith in our records of the past (6). Should an objector deny such faith, there is no trustworthy independent evidence for the past hypothesis. Lee argues that we should trust our records of the past because to deny them would be to throw out all observation-based science. The problem with such an assertion is that it draws a false equivalence between the contemporary observations which support fundamental laws (e.g. Newtonian mechanics) and backward facing cosmology. Conjectures about the beginning of the universe should not be placed in the same epistemic category as contemporary observation. As long as Lee draws an equivalence between big bang cosmology and more contemporary observations, she is not being charitable to the objection.

The second objection to the past hypothesis considered by Lee is "that the dynamic laws in statistical mechanics should be time-reversal asymmetric" (6-9). Lee's treatment of this objection greatly supports her argument because the true puzzle of thermodynamic time asymmetry is how time reversal invariant laws on the microscopic level produce time reversal noninvariant laws on the macroscopic level. Lee skillfully demonstrates the ineffectiveness of time reversal noninvariant microscopic theories of thermodynamics by showing that even these theories do not eliminate the need for a boundary condition (8). Lee might have taken this

section of her defense a step further by showing why a boundary condition alone is enough to explain the emergence of thermodynamic time asymmetry. Nevertheless, Lee convincingly argues against time reversal noninvariant microscopic theories by appeal to the remaining need for boundary conditions.

While Lee's argument is convincing, it is weakened by the absence of cited sources which object to the past hypothesis. Though it is clear that Lee is very knowledgeable in regards to the relevant topics, without citation of the objections, one cannot be certain that she is being charitable to the objectors. It would helpful to see the line of reasoning employed by the objectors themselves. As it stands, the reader is given only Lee's version of the accounts of anonymous objectors. This leaves one to wonder how opponents of the past hypothesis might choose to support their objection.

Lee is also very reliant upon big bang cosmology to defend the past hypothesis against opponents who call attention to the need for independent evidence. Should one deny the verity of big bang cosmology, Lee's argument falls apart. It seems that independent evidence from more fundamental sciences may still be needed.

In sum, "Statistical Mechanics and the Past Hypothesis" is a convincing defense of the past hypothesis which could be strengthened by the use of more sources and less dependence on cosmology.