Review of: "On the statistical arrow of time"

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Potential competing interests: No potential competing interests to declare.

I - general remarks

This paper raises some interesting questions about the topics of entropy and the arrow of time.

We shall consider separately the two main interrogations found in this article.

- first: is there really a link between the evolution of entropy and the arrow of time?
- secondly: more generally (not necessarily regarding the arrow of time), is entropy an objective entity?

Our comments will be organised on this double basis.

1. entropy and the arrow of time

   A system which is "*let to itself*" will obviously evolve in the sense of growing disorder, i.e. growing entropy. A system which is not "*let to itself*" can see its entropy decrease with time, such as the gas in the compressor of a cooling system. But what is a system let to itself, does this effectively exist? Some intervention is always more or less needed, either human or other: e.g. to open the bottle, free the gas, and let it spread into the entire room volume.

   The arrow of time is a non ambiguous reality of Nature. When you look at your face in the mirror, you get a clear conscience of the arrow of time.

   A system in statistical equilibrium won't give any information on the arrow of time. But there is always something moving in the universe, such as the rotation of the Earth, taken as the reference for UT time.

   Finally there is no link to be made between entropy and the arrow of time.
2. the deep nature of entropy

   In thermodynamics, we usually define entropy through its elementary variation dS: dS = dQ/T (with Q heat quantity, and T thermodynamic temperature).

   We can also define an absolute entropy S by: $S = k_B$ Log (Ω), with Ω number of possible microstates, and k_B Boltzmann constant.

   These definitions are perfectly objective.

   We need these definitions for scientific and technical purposes.

   But in some cases such definitions may appear as not adapted.

   Let us consider an example concerning information theory. The information contained in a character set may be quantified by entropy. If this set of characters constitutes a password, then entropy is not sufficient to characterise the performance of the password in terms of computer security. This, because some of the possible characters

arrangements (language words) are not equally probable with actually random ones. Hence the two main methods used for password cracking, the "dictionary search" and the "brute force attack".

A key parameter in all these problematics seems to be the *"ignorance of the observer"*. In the present article, a proposal is made, to quantify this ignorance by the volume $V_{\Omega j}$ of a region Ω_j of the state space.

Rather than making the statement that entropy is subjective, an alternative approach could be to create a new physical parameter to representing the subjective aspect, which would be more suitable for some of the encountered applications.

II - formal remarks

- a short reminder about Liouville's theorem could be useful to some readers, as there are several theorems known as Liouville's theorem
- In English, verbs at the third person singular should include an "s"