

Review of: "Thermodynamics, Infodynamics and Emergence"

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The paper by Klaus Jaffe introduces a unified approach to energy and information based on thermodynamics. I sympathize with this project, but think that the author does not succeed in convincingly making his case. This partly relates to the way how the argument unfolds. Especially in the beginning, the paper looks like a textbook chapter that introduces basic knowledge about the underlying physics. However, slowly concepts creep into the argument that are by no means textbook standard. This begins on page 6 when the concepts of 'social' and 'cognitive energy' are introduced without further explanation. These are not parts of the canon of thermodynamics, and seem very problematic: Firstly, in which sense do they differ from the more basic types of energy, such as chemical? – it is straightforward to argue that the 'social' (as in the human economy) just mobilizes these standard forms, such that there is no special other kind of energy involved. Secondly, both the social and the cognitive seem to relate much closer to 'information': For example, economists often conceive the market as a processor of information, even employing the metaphor of a computer. Then the distinction between energy and information gets blurred, if one would argue that there is a sort of 'social energy' in the market. In fact, the author later, when discussing his own approach to multidimensional systems, seems to suggest exactly this: It is information that organizes the harnessing and deployment of energy.

In my view, this creates a conceptual confusion which is continued when the author turns to information. For example, what is 'chemical information' as distinct from chemical energy? It is not of much help that the author simply lists various authors and their concepts of information while leaving open most basic issues such as whether information is a measure referring to the observer exclusively, or whether it is also a property of physical systems (which explains why the relationship between complexity and information is not simple, as the author notices), or what distinguishes quantities of information from semantic information. The author simply claims that none of the authors cited presents a satisfactory framework, without any justification. For example, I think that the Kolchinsky and Wolpert approach is very similar to what the author suggests.

As I understand his argument, he relates information to energy by positing a causal effect of information on the free energy of a system. This is an old idea, especially in the context of origin of life theories (see, for example: [Lahav et al. 2001](#)); the author picks up the topic of life later, but does not mention this existing research. His discussion is very similar to the approach by [Robert Ayres](#) whom he does not cite, especially when it comes to the notion of useful information. This shows that a more systematic exploration of the literature is necessary.

The lack of conceptual clarity also affects the examples. I do not understand why the engine is not involving information,

even in the author's sense, as the differential production of work and heat depends on the structure of the engine, which can be described in terms of embodied information.

All in all, the paper reaches out too far and overextends what is a messy conceptual frame. I recommend that the author should refrain from venturing too far into all these potential applications on different levels of complexity, but show how his approach can be applied for analyzing, say, the behavior of very simple organisms.