COMMENT ON A REVIEW BY P. W. ATKINS

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A recent essay review (Atkins, 1986), ostensibly of a book by K. G. Denbigh and J. S. Denbigh, seems more concerned with quoting from another work, and commenting on it in phrases not ordinarily seen in scientific journals. Yet this other work is not identified.

In the belief that the interested reader will wish to put the quoted remarks back into the context in which they were made and judge the issue for himself on the level of technical fact, we supply the missing reference (Jaynes, 1965). We note also that in the 22 years since that article appeared, the writer has published 19 other articles on the same general topic, part of a much larger literature in which the properties of entropy have been developed further, leading to new applications of the Gibbs formalism. Therefore we supply five key references which will afford entry into this currently active field.

The conceptual difficulties at issue here arise from failure to see the distinction between deductive physical prediction and inference. The former is available, at least in principle, when we know the relevant laws of physics and also the initial microstate of a system. Lacking this, we can still make the best inferences possible, taking into account the incompleteness of our information; as nearly all writers on statistical mechanics have recognized, predictions made with the second law lack the certainty of deductive proof, and are only highly plausible inferences.

One of these inferences, and perhaps the main functional use of entropy in thermodynamics, is to predict the work available in an isothermal process: $W = T\Delta S - \Delta U$. Some have argued that, since entropy has this "objective" physical meaning, it cannot represent a mere "subjective" measure of human information. However, we would observe that when we cause an interaction of some kind with a system, whether energy flows in one direction or the other depends on what microstate that system is in.

It is therefore a platitude, obviously valid in a much wider context than equilibrium thermodynamics, that the work we can extract from any system depends, necessarily, on how much information we have about its microstate. If entropy lacked this property of measuring human information, it could not serve its thermodynamic function.

In our view, far from attacking J. W. Gibbs, J. C. Maxwell and G. N. Lewis for their observations on the nature of entropy, we should applaud their insight in perceiving it so early. That today some have not yet comprehended their message only adds lustre to their accomplishments.

REFERENCES

P. W. Atkins, 1986, "Entropy in relation to complete knowledge", Contemp. Phys., 27, 257.

E. T. Jaynes, 1965, "Gibbs vs Boltzmann Entropies", Am. J. Phys. 33, 391. Here we demonstrate a generalised second law based on S = k log W as a necessary condition for reproducibility, even for changes between nonequilibrium macrostates. Note a typographical error: at a crucial point of the "anthropomorphic" argument the word "levels" should be read as "levers".

E. T. Jaynes, 1983, Papers on Probability, Statistics, and Statistical Physics, edited by R. Rosenkrantz (D. Reidel, Dordrecht-Holland). Reprints of the above article and 12 others, with commentaries. See particularly pages 18, 78, 238.

E. T. Jaynes, 1985, "Generalized Scattering". in Maximum Entropy and Bayesian Methods in Inverse Problems, edited by T. W. Grandy and C. R. Smith, (D. Reidel, Dordrecht-Holland), pp. 377-398. Notes the relation between the Clausius phenomenological entropy and the von Neumann information entropy.

E. T. Jaynes, 1985, "Macroscopic Prediction", in Complex Systems - Operational Approaches, edited by H. Haken, (Springer-Verlag, Berlin), pp. 254-269. Gives a hint of the generality of applications of S = k log W, once we see its connection with information.

E. T. Jaynes, 1986, "Predictive Statistical Mechanics", in Frontiers of Nonequilibrium Statistical Physics, edited by G. T. Moore and M. O. Scully, (Plenum Press, New York), pp 33-56. Cites many recent applications of entropy in astronomy, geophysics, and molecular biology.

W. T. Grandy, 1987 "Foundations of Statistical Mechanics" (D. Reidel, Dordrecht-Holland). A comprehensive review of this approach. All the same ideas are expressed, in slightly different words, with massive documentation.