On the use and abuse of *thermodynamic* entropy

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Entropy is a buzzword that is used by all kinds of communities, covering biologists, economists, social scientists and even writers. One may speculate that the term “Entropy” acts to provide their profoundness of thinking an appropriate scientific aura. One of the reasons for the bewilderment of the term Entropy is the unheralded appearance is the superabundance of situations bearing this expression. Being so, using the term thus requires that one does respect its precise meaning without effusing unnecessarily its wild growth, adding only to confusion rather than to clarity.

Here I will discuss more precisely its physical role of various notions for entropy. In particular, I will address the proper choice of entropy as it depends on the interests of the individual, the particular situations under study (classical or quantum regime), the degree of precision available and the type and method of description. I further will address the notion of entropy for systems of finite size and those situations of relevance in nanoscience, i.e. when the system under study is *strongly* interacting with its environment. Finally, I hope to address those intriguing (in parts highly controversial) subtleties occurring for the notions of *work* and *heat* in the deep quantum regime.

Relevant sources are:

[1] S. Hilbert, P. Hänggi, and J. Dunkel, *Thermodynamic Laws in Isolated Systems*, Phys. Rev. E **90**, 062116 (2014).

[2] P. Hänggi, S. Hilbert, and J. Dunkel, *Meaning of temperature in different thermostatistical ensembles*, Phil. Trans. Roy. Soc. A **374**, 20150039 (2016).

[3] P. Talkner and P. Hänggi, *Open system trajectories specify fluctuating work but not heat,* Phys. Rev. E **94**, 022143 (2016).

[4] P. Talkner and P. Hänggi, *Aspects of quantum work,* Phys. Rev. E **93**, 022131 (2016).