

24 Entropy

Subject:

“Entropy” is the name of a quantity that is introduced in classical thermodynamics as an abstract function, defined by an integral. This approach makes the quantity so aloof that it costs quite an effort even to the specialist to deal with it. Its interpretation as a measure of disorder is an approach that is favored by chemists, in order to get at least a rough understanding of its meaning.

Deficiencies:

It is an advantage of the chemist’s approach that entropy can be qualitatively seized, but this is not enough to satisfy the standards of the physicist. For a physicist a quantity is defined only if he knows a procedure to determine its values. Another flaw is that when using the disorder interpretation it seems that no simple macroscopic property corresponds to entropy.

Origin:

In the first half of the 19th century it became clear that the conservation of heat, as supposed by Carnot and others, was untenable. This brought in 1850 Clausius to try a restructuring of thermodynamics by supposing that heat and work can be transformed one into the other. In the scope of his work he constructed the quantity S , in order to describe the limitations of this mutual transformation.

Disposal:

In 1911 in a presidential address to the Physical Society of London its then president H. L. Callendar [1] pointed out that S is nothing else than a complicated reconstruction of the quantity that had been called heat by Carnot, the only difference being that now heat can be produced, but, as before, not destroyed. This insight arrived half a century too late to rectify the erroneous itinerary. One could conclude, however, that the quantity S not only has the same obvious intuitive meaning as the old heat, but it also can be quantified in the same simple way. Thereby the formalistic ghost S of classical thermodynamics could reduce to a concept that can easily be handled by a pupil of the elementary school, and the arsenal of now superfluous mathematical tools could be disposed of. This expectation is confirmed by great amount of experience at many schools [2]. In the role of heat S becomes, even under the featureless name of entropy, a quantity that is no more demanding than the concepts of length, time or mass. The fact that it appears in another raiment in information theory, statistical physics and the atomistic ideas of the chemists does not hinder it to appear in macrophysics in the role of heat.

[1] H. L. CALLENDAR: Proc. Phys. Society of London 23 (1911) 153. Callendar also proposes to abbreviate the legal unit J/K by Carnot.

[2] The Karlsruhe Physics Project, see for example
<http://www.physikdidaktik.uni-karlsruhe.de/>