The Thermodynamics Associated with Santilli's Hadronic Mechanics

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The new mathematics, referred to as iso-mathematics and geno-mathematics, introduced by Santilli to help explain a number of outstanding problems in quantum chemistry as well as in other areas of science such as astrophysics, has been applied successfully in a number of physical situations. This new formalism has, for the first time, provided an irreversible description of thermodynamics via an irreversible differential calculus together with the related mathematics. However, the associated thermodynamics has not been considered so far. That defect is remedied here.

1 Introduction

For many years now, science has harboured the belief that the theories of relativity and quantum mechanics offered the means to solve all outstanding theoretical problems. One person who has felt for many years that these theories are not complete is Ruggero Santilli. He has devoted his life to searching for extensions to these undoubtedly extremely successful theories. He was driven to this by the realisation that, despite a multitude of successes, a number of basic issues remained unresolved by orthodox quantum chemistry. Although a mountain of publications preceded it, the culmination of this work was presented in a monograph, *Foundations of Hadronic Chemistry* [1], which was produced in an attempt to provide possible explanations for a number of problems which had persisted for many years in the general area of quantum chemistry. In this book, he suggests a generalisation, or covering, of quantum chemistry, under the name "hadronic chemistry", which appears to resolve many of the outstanding problems. The suggested solution originates with the assumption that valence forces are nonlinear (in the wavefunction), non-local, and of non-potential type due to the deep overlapping of the wavepackets of valence electrons in singlet coupling. In turn, this "valence force" may not be represented quantitatively via conventional quantum chemistry since the latter is linear, local and potential. The covering of quantum chemistry for the invariant representation of the indicated new valence forces is based on a new mathematics called "iso-mathematics", which is itself based on real-valued (hermitian), nowhere singular yet arbitrary integro-differential units. Being, by fundamental assumption, incapable of representation via a Hamiltonian, these new valence forces are represented with the generalised integro-differential units. In turn, the representation of the new valence forces with a unit ensures the invariance of the theory, since the unit is known to be the basic invariant. The provision of simple means, utilising non-unitary transforms, for the construction of hadronic chemistry ensures that it differs from conventional theories.

In addition, an invariant formulation of irreversibility was presented also. The starting point for this was the historical legacy of Lagrange and Hamilton of representing irreversibility with the external terms in their celebrated equations — terms which are frequently ignored in modern expositions of the subject. For reasons of consistency, Santilli reformulates identically the original analytic equations in a form admitting a Lie-admissible structure in the sense of the American mathematician A. A. Albert. The formulation is extended from the classical to all branches. In this way, irreversibility emerges as originating from the most elementary levels of nature. Therefore, a possible resolution of the problem of reducing a macroscopic irreversible classical system to a finite collection of elementary particles, all in reversible conditions, is offered. This suggested formulation of irreversibility is based on an additional new form of mathematics known as "geno-mathematics". This is characterised by two real-valued, non-singular, non-symmetric, generalised units, interconnected by hermitian conjugates, one of which is assumed to characterise motion forward in time and the other, motion backward in time. The differences between the basic units for the two directions of time guarantee irreversibility for all possible reversible Hamiltonians. Since all potential interactions are reversible, these non-symmetric, generalised units represent the interactions responsible for irreversibility — namely, Lagrange's and Hamilton's external terms. This second set of methods is intended for an invariant representation of open irreversible processes, such as chemical reactions, and is part of the so-called genotopic branch of hadronic mechanics and chemistry.

However, the above generalisations were found not to resolve problems relating to anti-matter. To resolve these problems, it was found necessary to introduce yet more new mathematics. These further forms of mathematics are anti-isomorphic to the proposed iso- and geno-mathematics, have their own channel of quantisation, and the operator images are indeed antiparticles, defined as charge conjugates of conventional particles on a Hilbert space. As far as the applicability of well-known thermodynamics' results is concerned, it is only the thermodynamics of anti-matter via Santilli's isodualities which has been considered [2]. It remains to consider the position of the powerful thermodynamic results in iso-mathematics and geno-mathematics.

2 Iso-thermodynamics

The basic rules for iso-mathematics are laid out clearly in Santilli's book [1] but what must be noted at the outset is the importance of realising that in such typical thermodynamic expressions as TdS, multiplication of T by dS is indicated. Hence,

$$TdS = T \times dS \rightarrow \hat{T}\hat{\times}\hat{d}\hat{S} \rightarrow T \times \hat{I} \times \hat{K} \times \hat{d}\hat{S} \rightarrow T \times \hat{d}\hat{S}\,,$$

where

$$I \rightarrow \hat{I} = \frac{1}{\hat{K}} > 0\,.$$

Then

$$T \times dS \rightarrow T \times \hat{d}\hat{S} = T \times \hat{I} \times d\left(S \times \hat{I}\right) = \hat{I} \times TdS\,.$$

Hence, it follows immediately that,

$$dQ = dU + pdV \rightarrow \hat{d}\hat{Q} = \hat{d}\hat{U} + \hat{p} \times \hat{d}\hat{V} \rightarrow \hat{I} \times dQ = \\ = \hat{I} \times (dU + pdV) \Rightarrow dQ = dU + pdV$$

and

$$dQ = TdS \rightarrow \hat{d}\hat{Q} = \hat{T}\hat{\times}\hat{d}\hat{S} \rightarrow \hat{I} \times dQ = \hat{I} \times TdS \Rightarrow \\ \Rightarrow dQ = TdS\,.$$

This means that, within the iso-mathematical framework, the equations representing the first and second laws of thermodynamics hold in their familiar forms. A moment's consideration indicates that other familiar thermodynamic relations will also retain the familiar forms; for example, the Euler relation

$$TS = U + pV - \mu N\,,$$

the Gibbs-Duhem relation

$$SdT - Vdp + Nd\mu = 0\,,$$

and the expressions for the well-known thermodynamic potentials

enthalpy: $H = U + pV$,

Helmholtz Free Energy: $F = U - TS$,

Gibbs Free Energy: $G = U + pV - TS$.

3 Geno-thermodynamics

As far as the extension to include geno-mathematics is concerned, the basic rules of manipulation are again laid out in Santilli's book [1]. Application of these leads, for the combined first and second laws of thermodynamics, to

$$TdS = dU + pdV \rightarrow T^{>} > d^{>}S^{>} = d^{>}U^{>} + p^{>} > d^{>}V^{>}$$

which becomes

$$(TI^{>})\, I^{>-1}\left[I^{>-1}d\,(SI^{>})\right] = TdS = I^{>-1}d\,(UI^{>}) + \\ + (pI^{>})\, I^{>-1}\left[I^{>-1}d\,(VI^{>})\right] = dU + pdV\,.$$

However, here the genounit has been assumed constant. If the genounit depends on local variables

$$dS \rightarrow d^{>}S^{>} = I^{>-1}d\,(SI^{>}) = dS + SI^{>-1}dI^{>}\,,$$

and similarly for dQ and dW. Hence, in these circumstances the equation representing the second law takes the form

$$T^{>} > d^{>}S^{>} = d^{>}U^{>} + p^{>} > d^{>}V^{>} \rightarrow \\ \rightarrow TdS + TSI^{>-1}dI^{>} = \\ = dU + UI^{>-1}dI^{>} + pdV + pVI^{>-1}dI^{>} \Rightarrow \\ \Rightarrow TdS = dU + pdV\,,$$

since $TS = U + pV$.

Hence, even if the genounit does depend on local variables, the form of the equation representing a combination of the first and second laws of thermodynamics retains its familiar form. It may be noted that this is true of all the fundamental equations of thermodynamics when the extension into geno-mathematics is considered, just as was the case for iso-mathematics.

4 Conclusions

The end result of this discussion is simply to conclude that the familiar results of thermodynamics remain valid in their familiar forms in both iso-mathematics and geno-mathematics. These results all follow easily but are, nevertheless, important in that it confirms that the various results of thermodynamics may be used with confidence in conjunction with both iso-mathematics and geno-mathematics. It is worth remembering, however, that Santilli's new formalism achieves an irreversible description of thermodynamics through an irreversible differential calculus together with the related mathematics. Although it is shown here that the familiar thermodynamic results remain applicable in their familiar forms, it should be noted that the overall new formalism may be used to describe departures from the conventional laws which appear in several areas of science. This overall subject is relatively new and so the full extent of this claim is simply not known at present. Hence, it is important to embrace this new material with a truly open mind.

Further, it might be noted that, while a large number of Santilli's applications refer to what are essentially small systems and thermodynamics is a macroscopic theory, exactly how thermodynamics will apply in these cases is not yet completely clear. However, if a lead is taken from the work of Hill [3], it is readily seen that the familiar equations as modified for application to these small systems remain valid in both iso-mathematics and geno-mathematics.

Finally, it is worth realising that, for all its background as a collection of "facts of experience", thermodynamics in its well-known form continues to be applicable in all situations which arise for consideration. It is certainly a topic which can lay claim to be at the very heart of physics.

References

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