The Thermodynamics Associated with Santilli’s Hadronic Mechanics

Jeremy Dunning-Davies
Department of Physics, University of Hull, England
Institute for Basic Research, P. O. Box 1577, Palm Harbor, Florida 346822, USA
E-mail: j.dunning-davies@hull.ac.uk

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 latter 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 irreversible 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 con-
vventional particles on a Hilbert space. As far as the applica-
ability 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,

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

where

\[
I \rightarrow \hat{I} = \frac{1}{K} > 0 .
\]

Then

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

Hence, it follows immediately that,

\[
dQ = dU + pdV \rightarrow \hat{d}Q = \hat{d}U + \hat{p} \times \hat{d}V \rightarrow \hat{I} \times dQ = \hat{I} \times \hat{d}Q = \hat{I} \times TdS \Rightarrow \hat{d}Q = TdS .
\]

This means that, within the iso-mathematical framework,
the equations representing the first and second laws of ther-
mosdynamics hold in their familiar forms. A moment’s con-
sideration indicates that other familiar thermodynamic rela-
tions 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 po-
tentials

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 con-
cerned, the basic rules of manipulation are again laid out in
Santilli’s book [1]. Application of these leads, for the com-
bined first and second laws of thermodynamics, to

\[
TdS = dU + pdV \rightarrow T^\circ > S^\circ \Rightarrow d^\circ U^\circ + p^\circ > d^\circ V^\circ
\]

which becomes

\[
(TT^\circ) I^{\circ-1} [I^{\circ-1}d(SI^\circ)] = TdS = I^{\circ-1}d(UI^\circ) +
+ (pI^\circ) I^{\circ-1} [I^{\circ-1}d(VI^\circ)] = dU + pdV .
\]

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

\[
dS \rightarrow d^\circ S^\circ = I^{\circ-1}d(SI^\circ) = dS + SI^{\circ-1}dI^\circ ,
\]

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

\[
T^\circ > d^\circ S^\circ = d^\circ U^\circ + p^\circ > d^\circ V^\circ \rightarrow
\rightarrow TdS + TS I^{\circ-1}dI^\circ =
= dU + U I^{\circ-1}dI^\circ + pdV + pV I^{\circ-1}dI^\circ \Rightarrow
\Rightarrow TdS = dU + pdV ,
\]

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 funda-
mental 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 fa-
miliar forms in both iso-mathematics and geno-mathematics.
These results all follow easily but are, nevertheless, impor-
tant in that it confirms that the various results of thermo-
dynamics may be used with confidence in conjunction with
both iso-mathematics and geno-mathematics. It is worth re-
membering, 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 sys-
tems 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