Chapter Five

Hadronic Mechanics

Introduction

For roughly one hundred years now, science has almost complacently drifted along in a publicly assumed belief that Einstein's relativity theories, together with quantum mechanics, offered the true means of solving all the remaining theoretical problems of science. Put in this bald fashion, many would throw up their hands in horror. However, that is the situation the world of science has been facing for some time. For years, undergraduates have been told of the complacent attitude existing at the end of the nineteenth century when, the story goes, many eminent scientists believed all the theoretical tools necessary to solve all the world's scientific problems were known; it was simply a matter of time before all the answers were found. This sort of sentiment was, and is, often used as a prelude to introducing the theories of relativity and quantum mechanics in university undergraduate courses. The story also served to ridicule the scientific establishment in place at the end of that century. It might be thought that a lesson would have been learnt from this story, but no. At the end of the twentieth century, eminent scientists once again vociferously proclaimed the same position as that so falsely claimed at the end of the previous century. It seems that eminent scientists, like most other people, can be tempted very easily into making rather foolish claims in order to gain a little – in fact, a very little – short-term, high profile publicity, or should it be more properly be called notoriety? This is possibly a lesson the non-scientific public should learn. However eminent a scientist may be and in whatever field of science, he is still human and, as such, is prone to human frailties and mistakes like everyone else. It is often claimed the public, through the media, places individuals – be they sportsmen, politicians, philanthropists or scientists – on pedestals, only to destroy them if they err. There may be some truth in this assertion but surely, therefore, it is sensible not to allow oneself to be placed on such a pedestal in the first place? The rewards may be great, but the fall is so much greater!

In the present case, however, what of these claims concerning the theories of relativity and quantum mechanics? As has been seen already, there are grave qualms over the theories of relativity harboured by many people, but what of quantum mechanics? There have been worries expressed over some points in quantum mechanics almost from the very beginning of the subject. Frequently, these have revolved around the role of the observer and over whether or not quantum mechanics is an objective theory. One man who has considered these points at length is Karl Popper, probably one of the best known philosophers of science.

Although he has written on the topics at length, his book *Quantum Theory and the Schism in Physics*[*] proves an excellent source of his views. He expresses the view that the observer, or, as he prefers to call him, the experimentalist, plays exactly the same role in quantum mechanics as he does in classical physics; that is, he is there to test the theory. This, of course, is totally contrary to the so-called Copenhagen Interpretation, which provides the normally accepted position. This alternative view basically claims that "objective reality has evaporated" and "quantum mechanics does not represent particles, but rather our knowledge, our observations, or our consciousness, of particles".[†] As Popper points out, there have been a great many very eminent physicists who, over the years, have switched allegiance from the pro-Copenhagen camp. He cites among these Louis de Broglie and his former pupil Jean-Pierre Vigier, Alfred Landé and, in some ways most importantly, David Bohm. Bohm, himself an acknowledged and deeply respected thinker, wrote a book on quantum theory, which was published in 1951[‡], in which he presented the Copenhagen point of view in minute detail. Later, apparently under Einstein's influence, he arrived at a theory[§] "whose logical consistency proved the falsity of the constantly repeated dogma that the quantum theory is 'complete' in the sense that it must prove incompatible with any

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[*] K. R. Popper, 1982, Quantum Theory and the Schism in Physics (Hutchinson, London)

[†] W. Heisenberg, 1958, Daedalus, 87, 95

[‡] D. Bohm, 1951, Quantum Theory, (Prentice-Hall Inc., New Jersey)

[§] D. Bohm, 1966, Reviews of Modern Physics, 38, 453 more detailed theory"*. It was this very question of whether or not quantum mechanics is 'complete' which formed the basis of the intellectual struggle between Einstein and Bohr. Einstein said 'No'; Bohr claimed 'Yes'. The whole problem is discussed in great detail by Popper and, for those interested in this important topic, there can be no better reference than the book by Popper mentioned already.

However, where does Popper fit into anything to do with Hadronic Mechanics? Quite simply, the answer lies in the fact that it was in his 1982 book† that he, Karl Popper, drew attention to the thoughts and ideas of Ruggero Santilli. In the 'Introductory Comments' to his book, Popper reflects on, amongst other things, Chadwick's neutron. He notes that it could be viewed and indeed was interpreted originally as being composed of a proton and an electron. However, again as he notes, orthodox quantum mechanics offered no viable explanation for such a composition. Hence, in time, it became accepted as a new particle. Popper then notes that, around his (Popper's) time of writing, Santilli had produced an article in which the "first structure model of the neutron" was being revived by "resolving the technical difficulties which had led, historically, to the abandonment of the model"‡. It is noted that Santilli felt the difficulties were all associated with the assumption that quantum mechanics

* K. R. Popper, 1982, Quantum Theory and the Schism in Physics (Hutchinson, London)

† Ibid

‡ R. M. Santilli, 1981, Foundations of Physics, 11, 383

applied within the neutron and disappeared when a generalised mechanics is used. Later, at the end of section IV of his 'Introductory Comments', Popper makes the following assertion:

"I should like to say that he (Santilli) – one who belongs to a new generation - seems to me to move on a different path. Far be it from me to belittle the giants who founded quantum mechanics under the leadership of Planck, Einstein, Bohr, Born, Heisenberg, de Broglie, Schrödinger, and Dirac. Santilli too makes it very clear how greatly he appreciates the work of these men. But in his approach he distinguishes the region of the arena of incontrovertible applicability of quantum mechanics (he calls it atomic mechanics) from *nuclear mechanics* and *hadronics*, and his most fascinating arguments in support of the view that quantum mechanics should not, without new tests, be regarded as valid in nuclear and hadronic mechanics, seem to me to augur a return to sanity: to that realism and objectivism for which Einstein stood, and which had been abandoned by those two very great physicists, Heisenberg and Bohr".

Obviously, these comments of Popper will not be too well-received by some but, at the very least, they provide much food for thought and, considering his own well-deserved reputation, should convince people to assess Santilli's contributions with open minds.

As stated above, in more recent times, one man who has worried about the extent of the claims for these theories, both relativity and quantum mechanics, is Ruggero Santilli. He has devoted his life to studying them and attempting to extend the theories to cover situations to which they were not, in their usually accepted forms, truly applicable. The fact that they are, at the very least, not applicable in certain cases is something which is hidden from the public and from most students and Santilli's investigations have placed him squarely in opposition to the 'godfathers' of 'conventional wisdom'. All this has put him at a grave disadvantage in the scientific world and there seems little doubt that without the unswerving support of his wife, he would not have survived. Incidentally, it is worth noting, at this point, that this last statement is so true of so many who have opposed 'conventional wisdom'. Their wives have offered unstinting support ungrudgingly. For this, these courageous women – for that is precisely what they are - should be saluted and thanked by the entire scientific community, for their quiet moral support has to be recognised as a major factor in helping their husbands continue with their work in the face of so much hostile, scientifically unwarranted - indeed bigoted - opposition.

However, returning to the whole story surrounding Ruggero Santilli, as already noted, he has dedicated his life to examining the bases of relativity and quantum mechanics, feeling both theories to be incomplete. His investigations have led, in recent years, to possibilities for new clean energies and it is this which is now so important to consider, especially at this time when the world is so troubled by the depletion of energy stocks and worries about environmental effects of the energy sources presently being utilised so widely. This whole problem of future energy supplies is probably far more serious than usually imagined. Present demand is increasing but, when countries such as China, the Indian sub-continent and those of Africa come on line fully and require as much energy as the countries of the present west, that demand will escalate enormously. Given the present state of orthodox fundamental knowledge, the only realistic solution to this problem is presented by nuclear power. To many, this is not an acceptable option. Alternatives such as solar power, wind power, geothermal energy, wave energy, and others are all put forward but, in truth, these in total would come nowhere near satisfying the probable future demands for energy. No; as has been pointed out on several occasions*, the only realistic answer at the world's disposal at present is nuclear power. However, nuclear power is felt to pose two major problems and both are concerned with safety. The safety of the actual power stations is, not unreasonably, a tremendous worry for many. This is accentuated by incidents such as the Three Mile Island problem in the U.S.A. and, more recently, the disaster at Chernobyl. However, it is only the latter case that proved a true disaster; the first was fundamentally contained by the safety systems in place. There is little doubt that, provided adequate funds are made available, nuclear power plants can be made extremely safe, although, as with all man-made

* G. H. A. Cole, 1996, in Entropy and Entropy Generation, ed. J.S.Shiner; Kluwer Acad, Pub., Netherlands.
V. Castellano, R. F. Evans and J. Dunning- Davies, Nuclear Power and the World's Energy Requirements, arXiv:physics 0406046

structures, no-one can guarantee complete safety of anything and, whether those in authority like to admit it or not, genuine accidents will, and do, occur. Therefore, there can be no room for complacency but, if a sensible number of safety measures are incorporated into the plant, nuclear power stations should be safe. The disposal of nuclear waste, however, is another matter, as has been highlighted by all the problems being faced in the U.S.A. over its proposed storage facility in Nevada. This brings the story back to Santilli for another outcome of his work has been the emergence of a possibility for the safe disposal of nuclear waste in-house; by which is meant, the safe disposal of the waste without any need for transportation. The idea is still only at the theoretical stage and, as Santilli has been requesting for some time now, requires the performance of about three experiments to see if the theory actually works in practice. Such experiments would not be cheap to perform but, considering the enormous sums spent on some elementary particle work, the cost would not be too great and, if successful, the ensuing benefit for mankind would truly be out of all proportion to that cost!

Most will ask at this point why these experiments haven't been performed. This is a difficult, if not impossible, question to answer, but it may be noted that, on the one hand, the theory behind all this does not conform to 'conventional wisdom' and does, in fact, raise questions about the range of validity (at least) of the widely accepted theories of relativity and quantum mechanics, while, on the other hand, the theory has led already to the production of the new clean fuel, 'magnegas'! Hence, although the theory may be abstruse, may contain elements which some feel unacceptable, and may conflict with 'conventional wisdom', nevertheless something concrete has been produced which can be, and has been, used. The theory definitely appears to have had a readily identifiable success already. On the other hand, enormous profits are being made by people in the business of disposing of nuclear waste using the current somewhat crude and unsatisfactory methods. So the question arises as to whether, in some sense, 'conventional wisdom' and 'big business' have combined to prevent the performance of these experiments which, if successful, could have such a dramatic effect on both.

While the details of magnegas and its production are readily available via the internet (at www.magnegas.com or www.i-b-r.org) and may be read about in Santilli's book the *Foundations of Hadronic Chemistry**, it is worth noting that it was in 1998 that Santilli first built a so-called hadronic reactor of molecular type – something also known as a PlasmaArcFlow reactor. Such reactors make use of a submerged DC electric arc to achieve the recycling of nonradioactive liquid waste into a clean combustible gas called 'magnegas'. The process involved also produces heat, which may be used via exchangers, and some solid precipitates. These reactors provide an ideal means of disposing of most kinds of liquid waste –

* R. M. Santilli, 2001, Foundations of Hadronic Chemistry (Kluwer Academic Publishers, Dordrecht)

sewage, oil waste, other contaminated liquids and so on, - but may be used to process fresh or salt water also if necessary. In the above- mentioned book, Santilli comments that the best liquid for use in these reactors is crude oil, which may be processed into an extremely clean combustible gas at a fraction of the cost of normal refinery processing. However, the use of crude oil would hardly be beneficial in the present circumstances.

As is described in detail by Santilli*, the said reactors operate by liquids flowing through a submerged DC arc with at least one consumable carbon electrode. The arc decomposes both the liquid molecules and the carbon electrode into a plasma at approximately 3,500°K. This plasma is composed predominantly of hydrogen, oxygen and carbon atoms. The plasma is moved away from the arc as soon as it is formed and the reactor controls the recombination into 'magnegas', which bubbles to the surface where it is collected. Due to the known affinity of carbon and oxygen, oxygen may be removed from the plasma which results in combustible carbon monoxide. The removal, in turn, of this carbon monoxide, as soon as it is formed, then prevents its oxidation into carbon dioxide and so reduces the carbon dioxide content of the gas dramatically. The hydrogen essentially recombines into hydrogen molecules, although there are other products also.

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* Ibid

The use of an underwater arc is, of course, nothing new but, in other apparatus, the resulting carbon dioxide content of the emerging product is unacceptable environmentally. This is one of the bigger points in favour of this new technology. Again, the large glow normally created in underwater arcs is due to the recombination, following separation, of hydrogen and oxygen into water. This, of course, helps account for the low efficiency of the said underwater arcs. The new reactors, however, display a dramatic increase in efficiency due, at least in part, to the removal of hydrogen and oxygen from the arc immediately following their creation, thus preventing recombination into water. This hugely increased efficiency is a major plus for these new reactors and results in the production of a combustible gas at a price which is genuinely competitive with the cost of fossil fuels. When this overall cost is considered, it must be remembered that it will be arrived at after any income derived from the recycling of liquid waste and the utilisation of the heat produced has been taken into account.

'Magnegas' is largely unknown in many parts of the world and so, having introduced it as above, it is worth realising that it has been subject to extensive testing. The results are impressive! A Ferrari 308 GTSi and two Honda Civics have been converted to use 'magnegas'. One of these vehicles has been the subject of the above-mentioned testing. It has been found that 'magnegas' exhaust surpasses all the usual safety requirements without the use of a catalytic converter; emits no harmful carbon monoxide, carcinogenic or other toxic substances in the exhaust; reduces carbon dioxide emission due to petrol combustion by roughly 40%; and actually emits some breathable oxygen. This final fact is highly unusual since most fuels act to deplete the oxygen in the atmosphere; this one enhances it! However, not only is this final fact unusual, it is possibly highly important since, if the world continues with its present activities, what effect will oxygen depletion of the atmosphere have eventually? With all the talk of the dangerous environmental effects of present energy policies, oxygen depletion of the atmosphere is one rarely, if ever, mentioned. A further point of possible interest to motorists with a passion for performance cars, is that use of 'magnegas' as fuel doesn't seem to affect performance adversely, - at least not by much. In fact, a 'magnegas' fuelled Ferrari was privately raced successfully against conventionally fuelled Ferraris.

To conclude this introduction and justification for this chapter, it seems worthwhile to include a direct quote which appears in Santilli's book *Foundations of Hadronic Chemistry*, page 283. The quote is attributed to Mr. John Stanton, President of EarthFirst Technologies Inc., who states that

> "the new technology of PlasmaArcFlow Reactors is evolutionary, rather than revolutionary, because conceived to be primarily beneficial for crude oil, piston engines and hydrogen industries".

The interest in this claim is the use of the word 'evolutionary'. This is the way in which the work is perceived by an industrialist. How would, or indeed do, academics view it? It would surprise a great many people if the overall academic judgement failed to err on the side of revolutionary and actually moved to condemn Santilli's work for that very reason.

Hadronic Mechanics.

The book of Santilli's discussed in the introduction was published in 2001 and was produced to provide a possible explanation for a number of problems which had persisted for many years in the general area of quantum chemistry. After a century of research, despite a great many successes, a number of basic issues remained unresolved by orthodox quantum chemistry. Among these were:

(i) the lack of an exact representation of molecular data when derived from first principles, with deviations of the theory from experimental data on binding energies of the order of 2%;

(ii) the inability to permit accurate thermochemical calculations, since 2% is missing in the representation of the binding energies, corresponding to about fifty times the typical energy releases of thermochemical reactions, such as that in the formation of the water molecule;

(iii) the absence of an attractive valence force sufficiently strong to explain the strength of molecular bonds existing in nature;

(iv) the inability to restrict valence bonds to electron pairs only, thus essentially implying the prediction of molecules with arbitrary numbers of constituents;

(v) the incorrect prediction that all molecules are paramagnetic.

Obviously, the origins of Santilli's work go back much further and the applications are already much wider than is implied by the words 'hadronic chemistry'. The list of books, apart from all other publications, is impressive but contains mention of virtually all his contributions to various areas of science. However, whether he is considering a problem in astrophysics or biology, as he himself says, he approaches it as a mathematical physicist. Also, he took as his starting point a seemingly unshakeable belief in the idea that science, in general, doesn't admit complete and final theories, and could not progress without the introduction of some new mathematics. One immediate example illustrating this is provided by Newtonian mechanics, which had been so successful for so long, finding itself being regarded as a special limiting case of relativistic mechanics towards the beginning of the last century. Also, Einstein's general theory of relativity brought to the fore in the world of physics new mathematical methods. This new mathematics involved tensors and was reliant on earlier work by such as Riemann, Ricci and Bianchi. Hence, the huge change in physics at the beginning of the twentieth century was accompanied by new mathematics being introduced and used in physics and a well-established theory clearly being seen to be approximate and not final. Accordingly, Santilli turned his attention to producing new mathematics in order to deal with these new problems. To do this, he turned to the work of Marius Sophus Lie for some of his inspiration. After much intellectual effort, Santilli proposed so-called hadronic mechanics which is basically an image of quantum mechanics formulated via several completely new forms of mathematics, termed by him iso-, geno-, and hyper-mathematics, with so-called isoduals for antimatter. The corresponding iso-, geno-, and hyper-mechanics are then found to represent single-valued reversible, single-valued irreversible, and multi-valued irreversible systems respectively. Fundamentally, hadronic mechanics preserves all the usual laws and principles of orthodox quantum mechanics but represents what might be termed a completion of that subject, as seemingly required by the well-known argument of Einstein, Podolsky and Rosen (*The Physical Review*, **47**, 1935, 777). It is strongly suspected by many that Santilli's hadronic mechanics genuinely achieves this objective. However, the whole truth will be known only after the wider scientific community has examined the veritable mountain of material with an open mind. Incidentally, the names for these three new branches of mathematics/mechanics were constructed for the following reasons: firstly the 'iso' prefix, being short for isotopic which comes from the Greek and is meant to indicate the property of axiom-preserving for the new theory; secondly, the 'geno' prefix comes from genotopic which again follows from its Greek meaning which suggests an axiom-inducing property of that new theory; and finally, the term hyperstructural basically arose from ideas of multivalued functions. Further, iso-mechanics is fundamentally a non-unitary theory but is reversible; geno-mechanics preserves this property of non-unitarity but introduces ideas of irreversibility; hyper-mathematics goes even further and, while preserving non-unitarity and irreversibility, introduces multi-valuedness which increases the number of degrees of freedom open to the investigator and thus permits the study of far more complicated structures than was allowed previously.

It is not intended to discuss the precise details of any of these new forms of mathematics or, indeed, mechanics here but, suffice it to say, that a major difference between the forms of mathematics proposed by Santilli and the form with which everyone is so familiar, is that Santilli proposed using something other than the usual 'one' as the unit for his mathematics. For example, in the simplest form used for investigating anti-matter, the unit is -1, instead of 1. A very simple introduction to the use of this particular case is furnished by the examination of the associated thermodynamics as discussed in *Thermodynamics of Antimatter via Santilli's Isodualities* (*Found. Phys. Lett*, 1999, **12**, 593-599). In other forms, the structure proves more complicated. This immediately indicates that the new theories should be capable of discussing more complex systems of nature than was possible for classical and quantum mechanics since those theories only had real and complex numbers at their disposal. This limit placed by orthodox mathematics on mechanics, both classical and quantum, might be felt to be responsible, at least in part, for such theories having to make such suppositions as all particles being point-like.

At this point, it might be remembered that mathematics has long been termed the language of physics, but, with the principles of physics extending into so many regions of science these days, it might be termed the language of science more appropriately. That being the case, it is not too surprising if major changes, or even extensions, have to be introduced into our mathematical preconceptions when it comes to dealing with totally new situations.

To say that some of these situations are totally new might be thought something of an understatement, given some of the areas to which the new mathematics has been applied successfully. However, before considering that, it might prove beneficial to consider some reservations of current knowledge expressed by leading scientists of earlier years. Santilli himself admits to a lasting impression being left on him by several of these. In his book *Nuclear Physics* (University of Chicago Press, 1950), Fermi states on page 111 that "there are doubts as to whether the usual concepts of geometry hold for such small regions of space (those of nuclear forces)". This is, by itself, an extremely powerful statement by one of the leading scientific figures of his age but is it well-known, do people pay it due attention?

The answer to both those questions is probably 'No'. It is of further interest that the dedication of Santilli's book *Elements of Hadronic Mechanics*, Vol. 1, (Naukova Dumka Pub., Kiev, 1995), is to the memory of Enrico Fermi "*because of his inspiring doubts on the exact validity of quantum mechanics for the nuclear structure.*" Santilli also alludes to a statement included in Blatt and Weisskopf's book *Theoretical Nuclear Physics* (John Wiley, 1963) in which they speculate on page 31 on the possibility "that the intrinsic magnetism of a nucleon is different when it is in close proximity to another nucleon". In fact, this statement acted as a major spur to Santilli who claims to have produced a complete theory of total nuclear magnetic moments via his so-called hadronic generalisation of quantum mechanics. Whether or not he has achieved this is for the scientific community as a whole to decide but, until his work is read with open minds and properly digested, no final verdict can be sensibly announced. This indicates, once again, the urgent need for a totally open-minded examination of Santilli's work. A third, possibly rather obvious, source of inspiration was provided by the very well-known article by Einstein, Podolsky and Rosen which appeared in the journal *The Physical Review* (volume 47, page 777) in 1935, This article voiced concerns about quantum mechanics and it is worth realising that, until the day he died, Einstein continued to harbour real doubts concerning the lack of deterministic character of quantum mechanics. This again raises the question of how the scientific community, in general, regards Einstein. To many in the general public it is probably felt that he is still revered as the greatest scientist of the twentieth century. If that is the case though, it seems surprising that so many of his views and beliefs seem to be misrepresented. By referring back to his writings of the early years of the last century, it soon becomes apparent that here was a man who wrote very precisely and with great clarity. A good example of this is provided by his writings on Brownian Motion, now collected into a small book, *Investigations on the Theory of the Brownian Movement* (Dover, 1956). The writing in this small volume could well serve as an object lesson to all writers of science. Nevertheless, as commented on earlier when discussing black holes, there are several occasions where his views are kept well hidden, and have been kept so hidden for many years. It is not without significance to note that it is some of the truly 'big' names of twentieth century science who were voicing these qualms about the total validity of quantum mechanics over many years of the last century. These were also people who, it is well-known, were highly articulate. There was, and is, no reason to doubt what they were saying or about the grave doubts they were harbouring. In many ways the scenario is a repeat of that facing relativity in the earlier years, at least, of the last century. It is a sobering thought that, by this time, some may be wondering how science has managed to progress as far as it has, and with so much success. The added thought, however, has to be how much farther mankind might have progressed if unhampered by 'conventional wisdom' and all its attendant trimmings.

Another spur to Santilli's investigations was provided by the realisation that most of contemporary physics is concerned with the examination of systems subject to conservative fields of force; that is, subject to forces which are derivable from potentials. A good everyday example is provided by the gravitational field which so markedly affects our everyday lives. This is the example with which so many are familiar from school and which forms the basis for the introduction to the ideas of kinetic and, more importantly in the present context, potential energies. If the motion of an object held at arm's length before being released to fall to the floor is considered, it is seen to gather speed until it strikes the floor. At the instant before it actually strikes the floor, it is at zero distance above the floor but is moving at its highest speed during the entire motion. At that point, all its energy is said to be kinetic; that is, all its energy is due to its motion. However, at the initial moment of release, the object is not moving and so, has no kinetic energy. All its energy is due to its height, its position, above the floor. This energy is said to be potential energy; it is the energy which the object possesses because of its position and which gives it the potential for movement. This potential energy is purely due to the presence of the gravitational field, whose action pulls the object towards the centre of the earth or, in this case, towards the floor. This gravitational field is one of those force fields said to be conservative because potentials are associated with them. All the basic mechanics taught in schools and universities is done so under this restriction. Only rarely are situations for which there is no potential energy discussed. In a way this is not unreasonable since so much that affects us directly is governed by conservative fields of force. Newton's mechanics incorporating conservative fields of force are found to describe accurately both very small systems and very large systems. These days, problems of astronomy are considered at a variety of levels by everyone in his own home via well-established television programmes such as *The Sky at Night* and, since planetary motion is thought to be governed by a conservative field of force, this serves to reinforce the notion of such fields being all important, so that the possibility of non-conservative fields is often forgotten or even ignored. However, when the original writings of such as Lagrange and Hamilton on the analytical approach to mechanics are examined, no such restriction is apparent. This is certainly not clear in the vast majority of, if not all, undergraduate courses on Analytical Mechanics, as the whole area is commonly called. Restriction to conservative fields of force occurs at a very early stage. Of course, in fairness, to the undergraduate this does not seem at all unreasonable. Whether it be the mathematician or the physicist, the majority of actual situations met will be concerned with conservative fields of force. To a large extent, the same excuse for absence of consideration of more general situations from undergraduate lectures is valid but, in reality, attention to this restriction should be drawn. In mathematics lectures, no-one would contemplate drawing back from making *all* restrictions placed by a theorem crystal clear. This must be the correct approach, even though, in most cases, those restrictions will not affect the practising physicist. As has been pointed out on numerous occasions, when dealing with problems of the physical world, the physicist is regularly warned to be careful that mathematical restrictions on the use or applicability of a result may be coming into play by the physics of the situation. A perfect example to illustrate precisely what is meant by this is provided by the phenomenon of phase transitions. In the case of water, for example, it is patently obvious that something very unusual is happening when ice changes into liquid water and when that liquid water turns into steam. In both cases, it is observed that, at particular temperatures, as heat is added to the system, the structure of the substance changes but the temperature remains fixed. This is contrary to what is normally believed to happen when heat is added to a system. Hence, at these two temperatures of 0°C and 100°C for water, something very unusual is happening physically. This should alert the physicist to be wary; to be very wary of what is happening physically but, in some ways more importantly, to be wary of whether or not mathematical expressions remain valid. This is another good example of the use of mathematics as the language of physics; here the applicability of mathematics is ruled by the physics of the situation – not the other way around!

To return specifically to Santilli's contributions, it is remarkable to note to how many different outstanding problems he has turned his attention with this new approach and, apparently, with so much success. As mentioned, one of his earliest worries concerned the range of applicability of quantum mechanics. Having noted the comments and concerns of some truly notable scientists of the early part of the last century, he devised so-called Hadronic Mechanics and succeeded in explaining a wide variety of otherwise unexplainable phenomena. These are catalogued in detail in his book *Foundations of Hadronic Chemistry* but it is worth noting, and speculating on, some of them here; one in particular being particularly relevant to something which has preceded it, but more of that example later. As noted on page 35 of his book, explaining the experimental data on the Bose-Einstein correlation in proton - anti-proton annihilation at both high and low energy provided experimental verification of hadronic mechanics in particle physics. Such experimental data may be represented by traditional quantum mechanics only after the introduction of arbitrary parameters which seem to have no physical origin. However, hadronic mechanics is easily able to explain things because it proves capable of dealing with the off-diagonal terms appearing in expectation values. This latter property is not allowed in orthodox quantum mechanics because, for a quantity to be observable, its expectation value must be diagonal in form. This, of course, introduces mathematical terms into the discussion which, ideally, should be avoided but, suffice it to say, that the phenomenon may not be explained by orthodox quantum mechanics because it is too restricted as a theory. Another experimental verification, in the sense of the previous example, has been provided by the ability of the new theory to explain data concerning the anomalous behaviour of the mean-life of the kaon with energy. This has been examined successfully over various energy ranges and is important because, as with the example of the Bose-Einstein correlation, it establishes the existence of effects in the interior of kaons which are nonlinear, non-local and, most importantly, non-potential (that is, non-conservative).

As Santilli has stated quite categorically on several occasions but, possibly most clearly at the beginning of section 3 of his article in the *Journal of New Energy* (1999, **4**, page 106), he has always thought of physical particles as being particles which may be defined rigorously in our spacetime. He points out that hadronic mechanics was conceived and developed in order to identify the constituents of all unstable hadrons with genuine physical particles. Has he succeeded? Time will tell, but the positive evidence is there for all to see and is mounting. As has been seen already, any discussion of this topic inevitably seems to introduce mathematical ideas and notation at some point. Again as stated already, this is unfortunate but doesn't detract from an appreciation of the picture emerging and might serve as a spur for professionals to investigate the detail further in order to reach a truly informed opinion of the work.

From the point of view of physics, it seems that Santilli obtained inspiration from early ideas of Rutherford. It was in 1920 (*Proc. Roy. Soc. A*, 1920, **97**, 374) that Rutherford postulated the existence of a new particle, which was, in essence a 'compressed hydrogen atom'; that is, it was composed of an electron compressed entirely within the proton. This he called a neutron. Presumably Rutherford thought that, when a hydrogen atom is compressed, for example, in the core of a star, the high pressures involved could result in it being reduced in size to that of a proton, with an electrically neutral particle emerging finally. Twelve years later, Chadwick (*Proc. Roy. Soc. A*, 1932, **136**, 692) established the existence of the neutron experimentally. However, Rutherford's original conception of this particle was dismissed by many of the founders of quantum mechanics for a variety of seemingly good reasons at the time: - the model would require a positive binding energy; both constituents possess spin ½ and so, the resulting particle would not be permitted to have spin ½ by normal quantum mechanics; orthodox quantum mechanics would also not allow the correct magnetic moment to follow in this model. Hence, the rejection of Rutherford's model of a neutron and this heralded a change in the direction of physics' research. Up to that time, physics had been based on the notion that the constituents of so-called bound states have to be capable of being isolated and identified in laboratories. The rejection of Rutherford's conception appears to have altered this view. This then was the spur for Santilli and, having devised the new mathematics referred to earlier, he first succeeded in producing a consistent model of the meson, π^0, as a bound state of an electron and a positron. This model is not possible in conventional quantum mechanics for a number of reasons, one of which concerns binding energy. Quantum bound states possess negative binding energies and this implies a total mass less than the sum of the constituent masses. For a π^o meson, this would imply a rest energy appreciably less than its actual rest energy of 135Mev. This problem, as are all others, is resolved by hadronic mechanics or, at least, that is the claim with all the evidence clearly available for examination by those with a mind so to do. The model Santilli proposes does, in fact, explain all the characteristics of the said particle – zero spin, electrically neutral, null magnetic moment, a rest energy of 135Mev, a mean-life of approximately 10^{-16}sec., a charge radius of about 1fm (that is, 10^{-15}m), decay according to

$$\pi^o \rightarrow e^+ + e^-,$$

- and this model of the smallest of hadrons has now been extended successfully to all mesons. Further, although the theory does not view quarks as actual physical particles, but rather as mathematical objects with a composite structure, this new model for hadrons does prove compatible with the current quark theories, always assuming that quarks have a composite structure. For those interested, further details of this model may be found in a variety of publications but especially in volume **4** of the *Journal of New Energy*, as mentioned earlier. In fact this reference is a veritable goldmine of information on this general topic of hadronic mechanics and its consequences both for physics itself and probably for mankind as a whole through its consideration of the possibilities offered by the theory for alternative new clean energies.

However, what could conceivably turn out to be Santilli's most important achievement was his success in using the new hadronic mechanics to resurrect the Rutherford model for the structure of the neutron successfully. This model recognises a neutron as being composed of a bound state of a proton and an electron at a distance of 1fm; that is, at a distance of 10^{-15} m. As mentioned earlier, such a model is prohibited by conventional quantum mechanics, so, if Santilli's ideas are valid, what are the consequences for physics? The answer is, quite simply, enormous! The abandonment of the original approach to the structure of physical particles will have had a profound and far-reaching effect on research in the area of particle physics obviously. However, it is the possible ecological implications which are staggering and of so much direct relevance to absolutely everyone. The orthodox approach has conceivably prevented the study of the neutron as a major source of clean energy and actually seems to have obstructed the study of new forms of clean nuclear energy. These are now being studied via hadronic mechanics, as is the associated problem of the safe disposal of the nuclear waste presently causing so much trouble.

The main characteristics of the neutron, such as its having a rest energy of 939.6Mev, a mean-life of 916 secs., spin ½, and a charge radius of 0.8×10^{-13} cm., were all explained in a model of the neutron devised by Santilli using hadronic mechanics in 1990 (*Hadronic J.* **13**, 513). This was a non-relativistic treatment, but a relativistic treatment soon followed and appeared in 1993 (*JJINR Comm.* E4-93-352). The crucial point about this is that the model was precisely that proposed by Rutherford so many years earlier. Using hadronic mechanics, Santilli was able to derive all the properties of the neutron when it was viewed as being composed of an electron totally compressed inside a proton. This model, remember, had been abandoned because this structure was inexplicable using orthodox quantum mechanics. However, the fact that the Rutherford model may be explained using this new technique cannot, in itself, be regarded as justification for the new hadronic approach. The real justification is provided by the fact that there appears to be experimental verification of the structure in that experimental verification of the synthesis of neutrons from protons and electrons seems to have been achieved in the 1980's by a group in Brazil under C.Borghi, although the results were published only in 1993 (*J.Nucl.Phys.* (Russian) **56**,147). Although this is exciting, it is by no means conclusive evidence and that is precisely why caution is exercised when reporting and discussing this development. However, the possible ramifications are so important that it is vital for this experiment to be repeated several times so that a genuine conclusion may be reached which may be accepted by all in the scientific community.

The ramifications alluded to concern the possibility of utilising these new theoretical ideas to produce new clean energies for mankind. This again is a topic to which Santilli has devoted much time and energy over the years. Basically, many of these new energies are characterised by processes in the interior of hadrons, rather than in nuclei or atoms. It might be noted that energy is required if unstable hadrons are to be synthesised from physical particles; in the case of the neutron, 0.80Mev is required to synthesise it from protons and electrons. However, as Santilli points out (*Journal of New Energy*, 1999, **4**), "once created, unstable hadrons become a large reservoir of energy, which is released in their decay". Some of these proposed new energies, therefore, are produced by using mechanisms capable of stimulating the decay of unstable hadrons, or by simply using the energy produced in their natural decay. In this article, he goes on to describe the way in which energy could conceivably be produced via stimulated neutron decay. He also draws attention to the quantity of energy involved, pointing out that the electron emitted in neutron decay would possess energy roughly 100,000 times more than that of electrons hitting a computer screen. Again, it is noted that this mechanism is possible only if the neutron is composed of the physical particles, the proton and the electron. The main ideas behind the proposal are that the neutron does actually decay spontaneously. Also, its mean-life is not fixed but depends on local conditions; for example, if it's a constituent of some unstable nuclei, the mean-life is a few seconds; in a vacuum, it's more of the order of fifteen minutes; in other unstable nuclei, it's even longer; and in natural, light, stable nuclei, it's infinite. However, the neutron itself is naturally unstable and so it is felt it should be possible to stimulate its decay and hence control its mean-life. The actual proposal suggests testing this possibility through the use of photons with the resonating frequency of 1.204Mev, plus the additional threshold energy required to satisfy conservation requirements of

$$\gamma + n \rightarrow p^{+} + e^{-} + \nu.$$

Here the figure of 1.204Mev for the resonating frequency is another consequence of the hadronic model of the neutron adopted. It has been found, by studying nuclei, that most nuclei do not permit reactions such as that represented by the above equation due to violation of conservation laws. However, some do and it is these which offer the possibility of a new form of usable energy, termed by Santilli *hadronic energy*. In his book, Santilli chooses, as a representative example, Molybdenum ($_{42}Mo^{100}$) but also draws attention to the fact that other natural, light elements, such zinc ($_{30}Zn^{70}$), possess the required prerequisites. Most of this is still in need of experimental verification. It seems that, if successful, these tests would offer a prize too valuable to be ignored. It is to be hoped, therefore, that the necessary experiments will be performed in the very near future, so that existing doubts may be cleared up, one way or the other, finally.

A further important reason for having the predictions of hadronic mechanics fully and openly tested is provided by the rapid accumulation of highly radioactive nuclear waste around the world. This is proving a major problem for many countries. The U.S.A. has been seen to have a major problem of disposal and also to have an additional problem posed by those opposed to the current method for attempting to achieve that disposal. Britain, on the other hand, while facing problems concerning disposal of its own nuclear waste, faces additional protests from those opposed to its business of helping in the disposal of nuclear waste from other countries. In both instances, and in others, people are extremely worried by the perceived threat posed by the actual disposal method as well as that posed by the transportation of that waste across country. All of these worries have been exacerbated by the rapidly growing terrorism threat facing so much of the world. There can be no doubt that a great many people, some with scientific knowledge, some without such knowledge, harbour genuine worries. There can be no doubt also that those worries, and indeed fears, are not unjustified. The above discussion surrounding the composition of the neutron obviously offers the possibility of a resolution of the difficulties and concerns. These essentially reborn ideas concerning the structure of the neutron, if valid, offer the possibility of recycling nuclear waste by way of stimulating its decay in such a way as to reduce the extremely long lifetimes to hours or, at worst, days. It is envisaged that this could be achieved by the use of relatively light equipment and that the nuclear power plants could achieve this within their own boundaries, thus eliminating all transportation of these highly dangerous materials. If the idea works, although jobs in the industry presently formed around the disposal of nuclear waste would vanish, many new jobs in a much safer nuclear waste disposal industry would appear. The new industry might be expected to grow for the development, production and sale of the new equipment, since it would be a vital requirement for nuclear power plants throughout the world.

The basic idea revolves around the fact that the nuclei concerned are large and naturally unstable. One idea is to expose the highly radioactive nuclear waste to an intense, coherent flow of photons with the required resonating frequency. It is felt that this may be achieved via a synchrotron of about three metres diameter; - a size which could be accommodated in nuclear power plants. A typical example is provided by uranium ($_{92}U^{238}$) which has a life-time of the order of 10^9years. A double stimulated transmutation of this element could change it into Plutonium ($_{94}Pu^{238}$). Again, this is an unstable quantity and has harmful emissions as well, but its life-time is a mere 86 days and it could well be retained under suitable shields for that period of time. It may be superfluous to draw extra attention to this point, but it is worth noting the different life-times involved here – 86 days as against 10^9years! The phenomenal advantage of this stimulated transmutation is immediately evident. Will it work? The theory certainly suggests that it should, but only experimentation will give the actual answer to that question. Possibly the bigger, more relevant, question to ask at this time is whether or not the scientific community and national governments are prepared to finance the experiments necessary to test this thesis?

At this moment in time, it is worth realising that the cost of carrying out the proposed experiments would probably be of the order of a few hundred thousand pounds. This sounds a lot of money, and indeed it is. However, an experiment to detect neutralinos – those particles predicted by theory as candidates for so-called 'dark matter' which seems so important to preserve the currently accepted standard model in cosmology - has been running for sixteen years with no success so far. Nevertheless, it has been announced recently that those running this experiment are installing yet another new detector at the cost of one and a half million pounds! It has also been announced recently that, in America, a new extremely powerful super-computer has been used to create a three-dimensional model of two colliding black holes. Since this is purely computer experiment, it must be noted from the very outset that any results obtained will be totally dependent on the original input model and information. Both these factors will be completely dependent on present day knowledge and, possibly more importantly, theories. Hence, both will be influenced heavily by 'conventional wisdom'. Nevertheless, the results from this computer experiment are being heralded as very exciting and it is proposed to use this information to restart another sequence of very expensive experiments to seek evidence of such collisions, including yet another search for gravitational waves. This latter search is again, incidentally, another extremely expensive series of experiments which has continued for a great many years with, as yet, absolutely no success. This second proposed venture has not been costed as yet but will undoubtedly eat up millions of pounds of scientific research money. Fundamentally, no-one interested in science should be opposed to either of these two possible areas of research. Both will add, either positively or negatively, to human knowledge and, as such, are important. However, even if successful, neither will produce any immediate major benefit for mankind. If a few hundred thousand pounds were to be spent checking out Santilli's theories, the worst that could happen would be negative results; in which case a few hundred thousand pounds would have been wasted, but yet again, knowledge would have been gained. Negative knowledge may be, but knowledge nevertheless. If successful though, mankind's energy worries would recede into the background, at least for the immediate future, and nuclear power would become a so much safer option. Also, with the problem of the disposal of nuclear waste dealt with so that the genuine worries of so many would be assuaged.

However, the scientific establishment tends to regard orthodox quantum mechanics as a sacrosanct part of 'conventional wisdom', so it must be thought doubtful that it will sanction work which directly challenges that 'foundation stone of modern science'. The positions of national governments are far more difficult to assess. They will consult scientific advisers who will be members of the scientific establishment, so the line of their advice is probably predictable. They will be under pressure from a wide variety of areas of 'big business' but, no doubt, the most vociferous will be those wreaking profits from the present highly questionable methods of nuclear waste disposal. They will also, though, be under pressure from members of their electorates. If news of this possibility of there being a truly safe, in-house method of disposing of nuclear waste did become fully public, then it is probably this final factor that would weigh most strongly with national governments since, at the end of the day when all the political manœuvering and gesturing has been discarded, it is the thought of votes at the next election which would end up being of paramount importance. Can the possibility of the existence of such a prize really be ignored any longer?

The success in describing the above mentioned model for the neutron using this new hadronic mechanics opened the way to view afresh models for other systems, in particular the deuteron. Here an unresolved problem had lain around for years; that was the inability of conventional quantum mechanics to explain the value of one for the spin of the deuteron. The deuteron was felt to be composed of two particles, each having spin a half and the basic axioms of quantum mechanics would imply, therefore, a spin value of zero for the ground state of such a system. The new hadronic mechanics clears up this problem also. Following on from the reduction of the neutron to an hadronic bound state of a proton and an electron, the deuteron is viewed as a three-body situation comprising two protons and one electron – or, more accurately in Santilli's language, two iso-protons and one iso-electron. This model is able to represent accurately all the characteristics of the deuteron, including its spin. This success led Santilli to extend the notion to all nuclei. The result was to produce a new hadronic structure model of nuclei in terms of combinations of iso-protons and iso-electrons, which reduces to the usual model involving protons and electrons as a first approximation. This all seems at first sight to be merely another huge amount of almost unintelligible theory which will have little or no effect as far as the ordinary person is concerned. Amazingly, that is not the case. If this theory does turn out to be correct, the implications for society are immense because it could result in a number of new forms of clean energy for mankind's use; forms which are not possible with the old proton – neutron model. It does appear, therefore, that this is an area worthy of further open-minded investigation simply because the possible prize at the end is so attractive and, indeed, necessary considering the massive environmental problems and energy demands facing our world at the moment.

Further Applications.

So far, the applications discussed have been associated with elementary particles. It has been seen that, from this area alone, many benefits for mankind as a whole could accrue, if the predictions of the theory prove both accurate and achievable in practice. However, although a major factor in inspiring the researches which have led to these was the concern about energy resources, other fields may benefit from the development of these new mathematical techniques also. An unresolved problem facing astrophysics is one mentioned earlier, and that is the assertion by Arp that some quasars are physically linked with galaxies which appear to possess completely different redshifts. This assertion is based on, and supported by, a substantial body of observational evidence. Arp himself has offered an explanation, which revolves around the actual meaning, or interpretation, of the observed redshifts for objects. As mentioned earlier, he suggests that the redshift possesses two components and only one of these is the so-called Doppler shift; the other being an intrinsic component. The present position is, of course, to discount the interpretation of Arp's observations that the quasars and galaxies are linked physically and to continue to interpret the different redshift values as meaning that the quasars and associated galaxies are at totally different distances from the earth and are moving at totally different speeds relative to us. This, of course, is to interpret it simply as a Doppler type shift, is in line with 'conventional wisdom' and agrees with the accepted Einsteinian treatment of cosmological redshift. In 1991, using his new mathematics, Santilli suggested another explanation, (see *Isotopic Generalization of Galilei and Einstein's Relativities*, vols. I & II, Hadronic Press, 1991). His suggestion amounted to the difference being accounted for by a slowing down of the speed of light within the chromospheres of the quasars. It should be realised that these chromospheres are thought to be extremely large and the suggested effect is very similar to the slowing down of the speed of light within our own atmosphere. The result of this suggested slowing down would be for the light to leave the quasars – or more correctly, the quasar chromospheres – already redshifted. As far as the individual stars of the galaxy are concerned, they are effectively isolated in space and are thought to have dramatically smaller chromospheres. Hence, for the stars of the galaxy, the effect alluded to here will not exist. The end result is that, for physically connected quasars and galaxies having exactly the same expansion speed, the light from each will reach us here on earth with dramatically different redshift values. The reason advanced for the new theory being more suitable for explaining this effect is that traditional theory assumes everything both isotropic and homogeneous. It is thought, however, that chromospheres are both anisotropic and inhomogeneous. Hence, the need for utilising Santilli's iso-mathematics and related results to explain these observational results originally highlighted by Arp as discussed earlier. A further consequence is, of course, that redshift is not necessarily a measure of the expansion of the universe. This thought is not one to be accepted too readily by current adherents to 'conventional wisdom'. However, in the *Journal of New Energy*, volume **4**, evidence supporting this claim is presented clearly on page 103, where it is noted also that another verification offered within astrophysics for this new theory is provided by the quantitative – numerical representation of the internal red and blue shift of quasars. Basically, it seems that the cosmological redshift for each individual quasar is not constant but actually depends on the frequency of the light with an internal redshift for the infrared part of the spectrum and an internal blue shift for the ultraviolet part. These mean an increase and a decrease respectively of the cosmological redshift for these parts of the spectrum and are, of course, totally incompatible with special relativity since they imply different speeds of light for different frequencies in the interiors of quasar chromospheres. This behaviour is, however, predicted exactly by Santilli's modified theory. The studies associated with this topic also indicate that one contribution towards the red-sky viewed on occasions at both sunrise and sunset is isotropic in origin. The idea is that the anisotropic, inhomogeneous structure of the earth's atmosphere provides an additional contribution to the redshift at sunset since, then, the earth's rotation simulates motion away from the source. It is thought, therefore, that the larger redshift observed at sunset, as opposed to sunrise, is due to the rotation of the earth.

Again, when biological structures are investigated, it soon becomes clear that one of the biggest differences between those and the more usual physical systems is their non-conservative character. This latter thought is becoming more and more important in the present day as biology becomes more and more dependent on mathematics and theoretical physics in its development in some directions. At present, the biggest area where this occurs is possibly in the theory behind evolution where thermodynamics is playing an increasingly important role. Indeed, the Second Law of Thermodynamics really is appearing to look as if it may be one of those laws of nature whose influence pervades most, if not all, areas of science and even beyond. However, as far as Santilli's work is concerned, the power and range of applicability of his new mathematics is apparent when the problem of the growth of sea-shells is considered*. As he himself points out, it emerges that Euclidean geometry, with which

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*] R. M. Santilli, 1996, Isotopic, Genotopic and Hyperstructural Methods in Theoretical Biology, (Naukova Dumka Pub., Kiev)

most are so familiar, is insufficient for a consistent representation of the actual growth of sea-shells; the possible shapes of sea-shells are represented perfectly well by Euclidean geometry with no need for any extension into broader theories, but the generalised methods, introduced by Santilli, become vitally important when a detailed examination of the growth in time of these sea-shells is required. One major problem is that the growth of sea-shells is definitely non-conservative and also irreversible. However, the problem was eventually solved by Illert and Santilli* using the new iso-euclidean geometry as developed by Santilli. The use of the alternative geno-euclidean geometry might have proved more appropriate in some ways since it might allow for a deeper axiomatisation of irreversibility. Obviously, studies such as those alluded to here are in the early stages of applying this new mathematical structure to biological problems. It remains to be seen how widely this new mathematics will be used but, initially, the results of applying it to a wide range of problems are good and so it is to be hoped that mere 'conventional wisdom' will not hinder its future use in even more fields.

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* C. Illert and R. M. Santilli, 1995, Foundations of Theoretical Conchology, (Hadronic Press, Florida)