Ruggero Maria Santilli.

(Nomination for 2016 Nobel Prize in Chemistry)

Almost from the very beginning of the subject, worries have been expressed over some points in quantum mechanics. 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 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 Ruggero Santilli? Quite simply, the answer lies in the fact that it was in his 1982 book that Karl Popper drew attention to his thoughts and ideas. 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 applied within the neutron and disappeared when a generalised mechanics was used. 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 already, 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.

Ruggero Maria Santilli is an Italian-American scientist who was born in Capracotta, in the Italian region of Molise. He studied physics at the University of Naples before attending the Graduate School in Physics of the University of Turin, from where he graduated in 1966. In 1967 he was invited by the University of Miami to conduct research under NASA financial support. In 1968, Santilli became an Associate Professor of Physics at Boston University, teaching physics and mathematics, and conducting research for the United States Air Force. During this time, he became a naturalized American citizen. In 1976 and 1977 he was a visiting scholar at the Centre for Theoretical Physics of the Massachusetts Institute of Technology. During 1978 he was involved with research in the Mathematics Department at Harvard University. In 1983 Santilli became the President of his newly-formed Institute for Basic Research. He has devoted his life to studying the theories of relativity and quantum mechanics and attempting to extend them 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 many conventionally held scientific views. Nevertheless, he has persisted with his investigations.

As discussed in his book, *'Foundations of Hadronic Chemistry'*, after a century of research, despite a great many successes, a number of basic issues remained unresolved by orthodox theory. 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'. However, whether he is considering a problem in astrophysics or chemistry, 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. 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 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. It is strongly suspected by many that Santilli's hadronic mechanics genuinely achieves this objective.

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 presently available 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 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 is 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 one 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.

Many will wonder 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 is not conventional 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 a new clean fuel called 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. While the details of magnegas and its production are readily available via the internet, it is worth noting that it was in 1998 that Santilli first constructed a so-called 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 – sewage, oil waste, other contaminated liquids and so on, - but may be used to process fresh or salt water also. 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 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!

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 too adversely and here the present writer can attest to this after having driven a typical family saloon car, fuelled by magnegas, around the track at Monza and having personally experienced the performance. Incidentally, it might be noted also that magnegas is a far more efficient source of energy than acetylene when it comes to cutting though metal and, once again, the writer can attest to having witnessed a demonstration of this at Monza.

A major 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. 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 scientist. As has been pointed out on numerous occasions, when dealing with problems of the physical world, the scientist 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.

However, to return specifically to Santilli's contributions, it is remarkable to note to how many different outstanding problems he has turned his attention with his 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, many of which are catalogued in his book *Foundations of Hadronic Chemistry* (Kluwer Academic Publishers, Boston/Dordrecht/London,2001). In fact, this book is an excellent source of both information on his achievements and of the host of original references. Indeed, it is in the final chapter of this book that Santilli introduces a new chemical species, termed magnecules, in which atoms are bonded together into stable clusters by new internal attractive forces due to the magnetic and electric polarization of the orbitals of individual atoms, rather than of molecules. An impressive array of experimental evidence, supporting this new species, is presented also and more such evidence has accumulated since the first appearance of the said book.

It seems that Santilli obtained inspiration from early ideas of Rutherford, who 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 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. 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 succeeded in producing a consistent model of the meson, π^{o}, as a bound state of an electron and a positron.

However, what could conceivably turn out to be Santilli's most important achievement was his success in using 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 through 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 were all explained successfully in a model of the neutron devised by Santilli using hadronic mechanics. 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 is the one that 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 by a group in Brazil under C.Borghi. 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, "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. 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*. 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.

The applications discussed have been associated, directly or indirectly, 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. Indeed, it should be noted that many of the said predictions have been proved true already. 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. It would seem, therefore, logical to consider **Ruggero Maria Santilli** for the award of the

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– specifically for the discovery of the new chemical species of magnecules – the discovery which is at the heart of all that has been written above.

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