Article

Cosmic Contact To Be, or Not To Be Archimedean

Elemér E Rosinger[1]

Abstract

This is a two part paper which discusses various issues of cosmic contact related to what so far appears to be a self-imposed censorship implied by the customary acceptance of the Archimedean assumption on space-time.

Part I : Cosmic Contact Censorship: an Archimedean Fallacy ?

Abstract

It is argued that the customary, and rather tacitly taken for granted, assumption of the Archimedean structure of physical space-time may be one of the reasons why we experience Cosmic Contact Censorship. Further, it is argued that, once a non-Archimedean view of physical space-time is adopted, a variety of alternative worlds becomes open, a variety which may in part explain that Cosmic Contact Censorship.

0. Preliminaries

There is a well known literature on issues such as : "are we alone in the universe ?", "how many civilizations are out there in the galaxy or beyond ?", and so on, see [4] and its references for some of the more recent such contributions.
For convenience and brevity, and following the implicit suggestion of [4], let us call such issues CCC.

One of the familiar arguments when debating CCC issues is that, quite likely, life and/or intelligence in Cosmos, if any to exists beyond Planet Earth, need not necessarily be confined to its forms known to us so far on our planet. And if such may indeed be the case, then quite obviously we can face a considerably difficult issue, having to search for, and eventually recognize what we quite likely have no absolutely any idea about.

[1]Correspondence: Elemér E Rosinger Address: Department of Mathematics and Applied Mathematics, University of Pretoria, Pretoria, 0002 South Africa . Email: eerosinger@hotmail.com.

In this paper, however, another limitation in debating CCC issues is addressed, one that, so far, appears to have been missed altogether. Namely, it is related to what may turn out to be the excessive limitations in our conditioning as manifested in our usual perceptions and conceptions of space and/or time. Fortunately, this second limitation can be clarified much more easily, since it can be formulated in rather simple mathematical terms which, even if only intuitively, happen to be familiar to all of us.

1. Walking Inside the Traditional Archimedean Trap

As it happens, rather by an omission or default, than by any more conscious and deliberate commission, all sides involved in CCC arguments and disputes, whether supporting or denying the uniqueness in Cosmos of life and/or civilization on Planet Earth, seem to take rather for granted a Euclidean sort of mathematical model of space-time, and on occasion, its general relativistic version.

Needless to say, there is in fact a strong motivation for such a position, since until the beginning of the 20th century, science, and in particular mathematics, did not know or care much about space-time structures which were not Euclidean, or at least, were not locally so.

A remarkable fact in this regard, hardly ever considered according to its possible relevant implications, is that an essential feature of such type of space-time structures is in their being *Archimedean*. And this feature may turn out to be highly relevant to the issues of CCC.

In the simplest, one dimensional case of a Euclidean space, namely, of the real line $\mathbb{R}$, the Archimedean property simply means that there exists a positive real number $u \in \mathbb{R},\ u > 0$, such that for every real number $x \in \mathbb{R}$, there exists a positive integer $m \in \mathbb{N},\ m \geq 1$, with the property that $mu \geq |\, x \,|$.
Of course, we can for instance choose $u = 1$, or for that matter, any other strictly positive $u \in \mathbb{R},\ u > 0$. And then the Archimedean property simply means that, no matter where the point x would be on the real line $\mathbb{R}$, we can in a *finite* number of steps walk past x, if we start at the origin $0 \in \mathbb{R}$, and our steps are of length u.

Needless to say, geometry, especially as practiced at its historical origins in ancient times, could only be of practical use if it assumed the Archimedean property for the real line.

This Archimedean property extends naturally to Euclidean spaces, that is, to finite dimensional vector spaces over the real numbers $\mathbb{R}$. Indeed, on $\mathbb{R}^n$, with $n \in \mathbb{N},\ n \geq 2$, we have the following natural *partial order*. Given $x = (x_1, \ldots, x_n),\ y = (y_1, \ldots, y_n) \in \mathbb{R}^n$, then

$$x \ \leq \ y \iff x_1 \leq y_1, \ldots, x_n \leq y_n$$

Now if we take for instance $u = (1, \ldots, 1) \in \mathbb{R}^n$, then for every $x = (x_1, \ldots, x_n) \in$

$\mathbb{R}^n$, there exists $m \in \mathbb{N},\ m \geq 1$, such that $mu \geq |\, x \,|$, where $|\, x \,| = (|\, x_1 \,|, \ldots, |\, x_n \,|)$.

In particular, the set $\mathbb{C}$ of complex numbers, which as vector space over $\mathbb{R}$ is isomorphic with $\mathbb{R}^2$, also enjoys the Archimedean property.

Here we should further note that, on top of the practical geometric considerations, there is a deeper, and purely mathematical reason for us humans having ended up historically with such a fundamental, and in fact, exclusive role played by the real line $\mathbb{R}$ in mathematics and physics. Namely, as is well known in algebra, $\mathbb{R}$ is the only linearly ordered complete field which is Archimedean.

2. Beyond the Archimedean Conundrum

As mentioned however in [3], and in the literature cited there, recently there has emerged an interest in physics in considering mathematical models which use *other* scalars than the traditional real or complex numbers.
The reasons for such a venture may be numerous and varied. However, several pointers in this regard can be recognized as rather remarkable in being thought provoking.

One of them, of a markedly general and deep nature, is the question posed in [1] and asking how it comes that, so far, all the spaces used in physics, including general relativity and quantum theory, have a cardinality not larger than that of the continuum, that is, of the set $\mathbb{R}$ of real numbers ?
After all, ever since Cantor's set theory introduced in the late 1800s, we know about sets with cardinals incomparably larger than that of the continuum. Not to mention that the cardinal of the continuum is merely one the smallest infinite cardinals, and in fact, it is but the very second one, if we accept the Continuum Hypothesis.
Yet quite unfortunately so far, no one seems to be able to come forward with a credible answer to that question ...

A second pointer, perhaps somewhat more near to home, yet no less hard to disregard, arose in the 1960s, with the introduction of Nonstandard Analysis by Abraham Robinson.
Motivated by the need to create a rigorous mathematical theory for the "infinitesimals" used so astutely and effectively by Leibniz in Calculus back in the late 1600s, Robinson constructed an extension of the real line $\mathbb{R}$. This extension ${}^*\mathbb{R}$, called the *nonstandard reals*, is a linearly ordered field, just like $\mathbb{R}$ itself, however, it is - and as follows from the argument mentioned above, must be - *non-Archimedean.*

There have, of course, been several other candidates for sets of scalars which were suggested for use in the mathematical modelling of physics. Some of them are presented in the literature cited in [3].

The remarkable fact in this regard, and so far often missed, is that there is an arbitrarily large pool of sets of scalars which could be taken in consideration for the mathematical modelling of physics. This variety, described in [3], is given by a rather

easy and ubiquitous mathematical construction. As it happens, this construction, in several of its particular instances, is already known by many in mathematics, without however the widespread enough realization of the existence of a deeper underlying and unifying method. Indeed, the very construction of the real numbers from the rational ones, according to the Cauchy-Bolzano method introduced in the 1800s, is but one such instance, as it is the way metric spaces, or in general, uniform topological spaces, are completed in modern topology.
That deeper underlying unifying method is called "reduced powers" in terms of Model Theory, which is a branch of Mathematical Logic.
By the way, a particular and technically rather involved case of such reduced powers, called "ultrapowers", can be used in the construction of nonstandard reals $^*\mathbb{R}$ as well. As for the more general "reduced powers", their construction and use is significantly simpler.

In general, the mentioned reduced power construction can lead to *algebras* A of *scalars* which, unlike is the case with both $\mathbb{R}$ and $^*\mathbb{R}$, are no longer fields. In other words, these algebras A have "zero divisors", which means that in such algebras, and unlike in fields, one can have elements $a,\ b \in A$ whose product is zero, that is, $a.b = 0$, without a or b being zero. Consequently, in such algebras one cannot divide with every nonzero element.
However, such a restriction is *not* strange at all, since the same happens already with usual matrices. Furthermore, and unlike with matrices, such algebras A, if desired, can be constructed so as to have a commutative multiplication.

A remarkable feature of such reduced power algebras A is that they contain "infinitesimal" type elements, and as a consequence, they also contain elements which are "infinitely large". This leads to the fact, just like in the case of the nonstandard reals $^*\mathbb{R}$, that such algebras A are non-Archimedean.

3. Universes within Universes ... ad infinitum ...

In order to have a somewhat easier understanding of the effects of the non-Archimedean property as they may relate to the issues of CCC, let us return to the simplest one dimensional case of the nonstandard reals $^*\mathbb{R}$, and use it as an intuitive mental model, rather than the more richly structured reduced power algebras. Fortunately however, for this purpose, we do not have to get involved with the often elaborate technical details of Nonstandard Analysis, which are quite considerable when compared with the general construction of reduced power algebras presented in [3].

As noted above, the intuitive essence of the Archimedean property is that, in a finite number of steps, one can walk past every point in the respective space, no matter where one started to walk. In this way, an Archimedean space, like for instance the real line $\mathbb{R}$, is but *one single world.*

On the other hand, in a non-Archimedean space, such as that of the nonstandard reals $^*\mathbb{R}$, or of the reduced power algebras, one is *inevitably confined* to a very small part of that space when walking any finite number of steps, with the steps no matter how large, but of a given length. It follows that non-Archimedean spaces, among them the reduced power algebras, contain *many worlds* which are inaccessible to one another by the mentioned kind of walking, or at best, one of them is accessible to the other, but only in a most limited manner.

Let us try to clarify somewhat more this issue of accessibility, without however getting involved here in technical complications. For convenience, we denote by $WW_{u,\,x}$ the part of the non-Archimedean space, be it ${}^*\mathbb{R}$ or a reduced power algebra A, which can be accessed from a given point x through walking a finite number of steps of size $u > 0$.
Of course, it is easy to see that if we take any point $y \in WW_{u,\,x}$, then

$$WW_{u,\,y} = WW_{u,\,x}$$

Further, it follows easily that the nonstandard reals ${}^*\mathbb{R}$ and the reduced power algebras A do in fact contain *infinitely many* disjoint "walkable worlds" $WW_{u,\,x}$, each two of them being inaccessible to one another.

And as if to add to the surprises and wonders of such non-Archimedean spaces, such worlds $WW_{u,\,x}$ can not only be outside of one another, but they can be *nested* within one another in infinitely long chains. This is but a simple and direct algebraic effect of the fact that some "infinitesimals" can be infinitely larger, or for that matter, infinitely smaller, than other "infinitesimals". Similarly, some "infinitely large" elements can be infinitely smaller, or alternatively, infinitely larger than other "infinitely large" elements.

For instance, in the case of the nonstandard reals ${}^*\mathbb{R}$, let us take $u = 1,\ x = 0 \in \mathbb{R} \subsetneqq {}^*\mathbb{R}$. Then $WW_{u,\,x} \supsetneqq \mathbb{R}$, yet it is known that $WW_{u,\,x}$ is but a tiny part of the whole of ${}^*\mathbb{R}$. In fact, if we take $v \in {}^*\mathbb{R} \setminus \mathbb{R}$, then again $WW_{u,\,x} \subsetneqq WW_{v,\,x}$, with the former being but a tiny part of the latter. Furthermore, the latter is still a tiny part of the whole of ${}^*\mathbb{R}$.
And as it happens, each of the walkable worlds $WW_{u,\,x}$, no matter how one would choose $u,\ x \in {}^*\mathbb{R}$, is but a tiny part of the whole of ${}^*\mathbb{R}$.

Added to this comes the story of infinitesimal walkable worlds. For instance, if we take $u = 1,\ v = \epsilon,\ x = 0 \in {}^*\mathbb{R}$, where $\epsilon > 0$ is a nonstandard positive infinitesimal, then $WW_{v,\,x} \subsetneqq WW_{u,\,x}$, and the former is again only a tiny part of the latter.
However, we can take both $u,\ v > 0$ to be positive infinitesimal, and we can further assume that v/u is itself an infinitesimal. In that case we shall again have $WW_{v,\,x} \subsetneqq WW_{u,\,x}$, with the former once more but only a tiny part of the latter.

In the case of the nonstandard reals ${}^*\mathbb{R}$, we can conclude as follows. Given $u,\ v,\ x,\ y \in {}^*\mathbb{R},\ u,\ v > 0$, the corresponding walkable worlds $WW_{u,\,x},\ WW_{v,\,y}$ can be in one and only one of the next three situations :

1) $WW_{u,\,x} = WW_{v,\,y}$

2) $WW_{u,x} \bigcap WW_{v,y} = \phi$

3) $WW_{u,x} \bigcap WW_{v,y} \neq \phi, \quad WW_{u,x} \neq WW_{v,y}$

in which case, either

3.1) $WW_{u,x}$ is an infinitesimal part of $WW_{v,y}$

or

3.2) $WW_{v,y}$ is an infinitesimal part of $WW_{u,x}$

Furthermore, the situation at 2) does happen infinitely many times, and in particular, each walkable world $WW_{u,x}$ is merely an infinitesimal part of the whole of $^*\mathbb{R}$. As for the situation at 3), the respective nestings of walkable worlds have infinite length.

Needless to say, in the case of reduced power algebras which, as mentioned, have a richer structure than the nonstandard reals $^*\mathbb{R}$, the above three situation manifest themselves in yet more complex ways.

4. Do We Live in One Universe ? Are the Quanta the Smallest Possible Entities ? And what about Time ?

It is quite remarkable, although often missed to be noted, or in fact simply disregarded, that much of classical mechanics is subjected to what is called Dimensional Analysis, [2]. In other words, all respective physical entities can be defined in terms of only three fundamental ones, namely, *length, mass* and *time*. Furthermore, in terms of the respective definitions, all the corresponding physical entities are elements of *scaling groups*, which means that there is *no* natural, unique or canonical way to choose their units, and on the contrary, those units can be chosen arbitrarily, and merely upon convenience.

This clearly implies that each of the three fundamental physical entities is supposed to belong to an Archimedean space, namely, $\mathbb{R}$ in the case of length and time, and $[0, \infty) \subsetneqq \mathbb{R}$, in the case of mass.

As for quantum mechanics, such an approach is of course no longer accepted, due to the radically different assumption of the existence of *minimal* values for various physical entities involved, values called the respective "quanta".

And yet, the passing from classical mechanics to quantum mechanics has not led to the abandonment of the Archimedean assumption. And the fact is that, as things stand so far, it did not have to do so. Indeed, all what happened was that in the case of quantized physical entities, corresponding intervals of real numbers were simply excluded from the real line $\mathbb{R}$. For instance, let $q > 0$ be the quantum quantity for a certain physical entity, then instead of the respective quantity being able freely to range over the whole of $\mathbb{R}$ as it may happen in classical mechanics, now it is only allowed to do so over the *discrete* subset of $\mathbb{R}$, given by $\mathbb{Z}q$, that is, the integer multiples of q.

Given such a state of affairs, including in general relativity and quantum mechanics, it is no wonder that in cosmology we still assume, even if not explicitly and up front, that real, physical space is exhausted by $\mathbb{R}^3$, or rather, by some curved general relativistic version of it, while real, physical time is like $\mathbb{R}$.
In other words, we still think within the limitations of a *one world* Archimedean world view ...

And then the question arises :

- What if indeed we may in fact live in non-Archimedean worlds, be it space-wise, or time-wise, or for that matter, in both of these ways ?

And if it may happen that we do live in such non-Archimedean worlds, then the respective alternatives 1) - 3) in section 3 may actually apply. Not to mention that in case reduced power algebras more rich in structure than the nonstandard reals may be adequate for modelling physics, yet more complex alternatives could be encountered.

And quite clearly, the mentioned alternative 2) already bring in a dramatic situation related to CCC. Indeed, it is hard to imagine what kind of communication may ever take place between two such disjoint walkable worlds, be they disjoint space-wise, time-wise, or in both of these ways ...
Interestingly enough, the situation is not much simpler in the case of alternative 3), that is, even if two walkable worlds may happen to have a common part. Namely, in such a case one of such worlds must be contained in the other, but then, it is contained as a mere infinitesimal part. Therefore, again, it is hard to imagine what kind of communication may ever take place between two such walkable worlds ...

Finally, let us note that, especially related to *time* in the above alternative 3) there seem to be immense difficulties with respect to CCC between such two walkable worlds WW and $WW\,'$.
Namely, if we are in the walkable world WW which infinitesimally small compared with $WW\,'$, then during our own time quite nothing seems to happen in $WW\,'$, due to the respective infinite disproportion between the time scales involved. In this way, we in WW may see $WW\,'$ as merely frozen, dead, or immobile ...
Conversely, if $WW\,'$ is infinitesimally small compared with our walkable world WW, then events in $WW\,'$ may happen infinitely fast when seen in our own time scales. Therefore, again, we may simply not be able to take notice of them, thus once more seeing $WW\,'$ as merely frozen, dead, or immobile, even if because of the totally opposite reason ...

The fact is that, those among us who have for a while been working in Nonstandard Analysis, or with reduced power algebras, do not feel anything strange about the kind of rather complex compartmentalization of walkable worlds described in 1) - 3) in section 3.

And needless to say, Nonstandard Analysis has during the last four decades proved its remarkable value both in mathematics and its applications, among the latter, stochastic analysis, [5].

As for various reduced power algebras, beyond the scalar ones used in [3], they have over the last more than four decades proved their utility in solving very large classes of earlier unsolved linear and nonlinear PDEs, [6-22]. Indeed, such reduced power algebras can give an infinitely large class of differential algebras of generalized functions, each containing the Schwartz distributions. The respective differential algebras of generalized functions, and among them in particular, the so called Colombeau algebras, proved to be able to provide for the first time in the literature suitable generalized solutions within a systematic *nonlinear* theory of generalized functions, a theory not available within the classical Sobolev or Schwartz linear distribution theories.

References

[1] Roger Penrose : The Road to Reality, a Complete Guide to the Laws of the Universe. Jonathan Cape, London, 2004.

[2] Elemer E Rosinger : Two problems in classical mechanics. arXiv:physics/0407042

[3] Elemer E Rosinger : From reference frame relativity to relativity of mathematical models : relativity in a variety of non-Archimedean setups. arXiv:physics/0701117

[4] Pushkar Ganesh Vaidya : Cosmic Contact Censorship. arXiv:physics/0702172

[5] Sergio A. Albeverio, Jens E. Fenstad, Tom Lindstrom, Raphael Hoegh-Krohn : Nonstandard Methods in Stochastic Analysis and Mathematical Physics. Elsevier, Amsterdam, 1986

bibitem Elemer E Rosinger : Distributions and Nonlinear Partial Differential Equations. Springer Lecture Notes in Mathematics, Vol. 684, 1978 (146 pages)

[6] Elemer E Rosinger : Nonlinear Partial Differential Equations Sequential and Weak Solutions. North-Holland Mathematics Studies, Vol. 44, 1980 (317 pages)

[7] Elemer E Rosinger : Generalized Solutions of Nonlinear Partial Differential Equations. North Holland Mathematics Studies, Vol. 146, 1987 (409 pages)

[8] Elemer E Rosinger : Nonlinear Partial Differential Equations, An Algebraic View of Generalized of Generalized Solutions. North-Holland Mathematics Studies, Vol. 164, 1990 (380 pages)

[9] Elemer E Rosinger : Parametric Lie Group Actions on Global Generalized Solutions of Nonlinear Partial Differential Equations and an Answer to Hilbert's Fifth Problem. Kluwer Acad. Publ., Dordrecht, London, Boston, 1998 (234 pages)

[10] Elemer E Rosinger : Embedding the D′ Distributions into Pseudotopological Algebras. Stud. Cerc. Mat. Acad. Romania, Vol. 18, No. 5, 1966, pp. 687-729

[11] Elemer E Rosinger : Pseudotopological Spaces, Embedding the D′ Distributions into Algebras. Stud. Cerc. Mat. Acad Romania, Vol. 20, No. 4, 1968, pp. 553-582

[12] Elemer E Rosinger : Division of Distributions. Pacific Journal of Mathematics, Vol. 66, No. 1, 1976, pp. 257-263

[13] Elemer E Rosinger : Nonsymmetric Dirac Distributions in Scattering Theory. Proceedings of the Fourth Conference on Ordinary and Partial Differential Equations, Dundee, Scotland, 1976, Springer Lecture Notes in Mathematics, Vol. 584, pp. 391-399

[14] Elemer E Rosinger : Global Version of the Cauchy-Kovalevskaia Theorem for Nonlinear PDEs. Acta Applicandae Mathematicae, Vol. 21, 1990, pp. 331-343

[15] Elemer E Rosinger : Characterization for the Solvability of Nonlinear PDEs. Transactions of the American Mathematical Society, Vol. 330, No. 1, March 1992, pp. 203-225

[16] Elemer E Rosinger, Yvonne E Walus : Group invariance of generalized solutions obtained through the algebraic method. Nonlinearity, Vol. 7, 1994, pp. 837-859

[17] Elemer E Rosinger, Yvonne E Walus : Group invariance of global generalized solutions of nonlinear PDEs in nowhere dense algebras. Lie Groups and their Applications, Vol. 1, No. 1, July-August 1994, pp. 216-225

[18] Elemer E Rosinger : Arbitrary global Lie group actions on generalized solutions of nonlinear PDEs and an answer to Hilbert's fifth problem. In (Eds. M Grosser et.al.) Nonlinear Theory of Generalized Functions. Pitman Research Notes in Mathematics, Longman, Harlow, London, 1998, pp. 251 - 265

[19] Anastasios Mallios, Elemer E Rosinger : Abstract differential geometry, differential algebras of generalized functions, and de Rham cohomology. Acta Applicandae Mathematicae, Vol. 55, No. 3, February 1999, pp. 231 - 250

[20] Anastasios Mallios, Elemer E Rosinger : Space-time foam dense singularities and de Rham cohomology. Acta Applicandae Mathematicae, Vol. 67, No. 1, May 2001, pp. 59 - 89

[21] Elemer E Rosinger : How to solve smooth nonlinear PDEs in algebras of generalized functions with dense singularities (invited paper). Applicable Analysis, Vol. 78, 2001, pp. 355-378

[22] Anastasios Mallios, Elemer E Rosinger : Dense singularities and de Rham cohomology. In (Eds. Strantzalos P, Fragoulopoulou M) Topological Algebras with Applications to Differential Geometry and Mathematical Physics. Proc.

Fest-Colloq. in honour of Prof. Anastasios Mallios (16-18 September 1999), pp. 54-71, Dept. Math. Univ. Athens Publishers, Athens, Greece, 2002

Part II : On Cosmic Contact Self-Censorship

Abstract

Before delving into the issue of cosmic contact, or its possible censorship due to various sources, it is important to clarify as much as possible the meaning of the concept of such, or for that matter, any other relevant possible contact. Without a more appropriate a priori clarification, it is most likely that we ourselves may actually enforce a censorship, even if we do so not consciously. This paper points to several possible conceptual obstacles in the venture of clarifying as much as possible the meaning of contact, be it cosmic or of other nature. Such a clarification is seen as a necessary step in order to avoid unintended self-censorship. In particular, in case we may at last consider non-Archimedean space-time structures as well, then what we usually call "Cosmos" may in fact happen to be everywhere inside and nearby, all around us, as well as at distances never imagined in our usual Archimedean paradigms. This, in its remarkable richness and complexity, is in stark contradistinction with the poverty of "one single Cosmos, and out there" typical of the Archimedean vision.

1. Preliminaries

Cosmic contact, as in fact any sort of contact, can have a large variety of meanings. And by missing to be aware of specific possible meanings, we significantly increase the likelihood of exerting a de facto, even if not conscious, self-censorship.
In this regard, there can at least be two ways in which our meaning of contact suffers from restrictions. One of them, quite likely by far the most difficult to overcome, is the overall limitation of human awareness at any specific given time. The other one, possibly easier to deal with, is due to the limitations we impose, and do so without being conscious about that fact, upon the assumptions which happen to constitute the conceptual background within which we are looking for possible meanings for the phenomenon of contact.

Related to that second way, the way in which our background conceptual assumptions can limit the meanings we associate with the phenomenon of contact, it was pointed out in [4] that the usual Archimedean assumption on the structure of space-time, so prevalent, if not in fact the only one, in modern Physics, may actually be the source of a major self-censorship, one which we keep failing to become conscious of. Further details related to this argument were presented in [2,3].

That second way, which can be the source of much - and at the same time, less than conscious - self-censorship, has at least two manifestations, namely, in :

- our background assumptions about "where in space and time we are supposed to be looking for possible contact", assumptions at present of a near exclusive Archimedean nature,

and rather independently of that

- "what kind of contact" we keep thinking about, thus by implication excluding other possible variants of it.

In [4], the first of these two manifestations was considered, and the lack of a sufficient awareness about the possibility of a non-Archimedean space-time structure was pointed out, indicating at the same time the surprising richness and complexity of the *self-similar* nature of non-Archimedean structures.
Here we shall consider the second above alternative, and we shall point out that the concept of contact, thus its meaning as well, can have at least two rather different variants, namely :

- direct contact,
- indirect contact.

Furthermore, the second variant can also have at least two significantly different sub-variants, namely :

- contact in which the contactees are aware of it,
- contact in which at least one of the contactees does not become aware of it.

2. Recalling Briefly a Few Relevant Features of non-Archimedean Space-Time Structures

The radically more rich and complex features of non-Archimedean space-time structures, reflected already in the simplest one dimensional case of the nonstandard real line $^*\mathbb{R}$, are manifested in the corresponding *self-similar* structures which recall essential properties of fractals. This fact, therefore, should already affect our perceptions and conceptions of *time*. When it comes to *space*, needless to say, higher dimensional instances of non-Archimedean structures may become involved, with their yet more rich and complex features.

As for what may appear as the simpler, one dimensional case of time, two of the essential novelties in its non-Archimedean instances are the following :

- there are plenty of "times beyond, of before all time", and
- there are plenty of "times within every single instant of time".

Therefore, even if we keep to our Archimedean perceptions and conceptions of space, and only let in non-Archimedean structures in the one dimensional case of time, we already have a major problem in establishing the meaning of contact. Indeed, in such a case, entities "beyond or before time" may be in direct contact with

us, yet we may never become aware of that, if we keep to our present Archimedean background assumption about time. A similar situation can, of course, happen with entities which exists in "times within every single instant of time".
In particular, a mere usual instant can prove to be nothing short of "eternity" for certain worlds. And dually in a way, what is "eternity" in our Archimedean perception and conception of time may be no more than a mere instant, when considered in non-Archimedean contexts.

Needless to say, in case space is allowed a non-Archimedean structure, we immediately end up with far more rich and complex structures in which :

- there are plenty of "spaces beyond all space", and
- there are plenty of "spaces within each and every single space point".

And such non-Archimedean structures can similarly, if not even more, affect the meaning of contact. After all, we, in our finiteness in space, as seen from the Archimedean point of view, can in fact be hosts to infinitely many worlds, worlds which appear to us, and are conceived by us a mere "negligible infinitesimal" ones. And in a sort of duality, what is the Archimedean Cosmos for us may in fact be altogether but a "negligible infinitesimal" realm ...

Clearly, what has so far been conceived as cosmic contact, for instance, by projects such as SETI, is supposed to take place exclusively within an Archimedean space-time structure. And the contact is only supposed to be between us humans, and on the other hand, entities somewhere far out there in the Cosmos, or at least, outside of our Planet Earth, but most certainly not beyond the confines upon time and space the Archimedean assumption imposes. And of course, such contacts are even less supposed to be with entities within the infinitesimal realms non-Archimedean space-time structures allow in such an abundance.

3. One Reason To Be Careful when Deciding what Space-Time May Really Be

As argued in [5], see also [2], present day Theoretical Physics does so strangely and systematically disregard, or even worse, what a Descartes used to call "res cogitans". And such an attitude manifestly flies in the face of most simple phenomena which can be formulated in rather clear questions. Questions which Theoretical Physics continually fails to consider, let alone, deal with. Here are some of them, as cited form [5,2].

3.1. Within Newtonian Mechanics. Instant action at arbitrary distance, such as in the case of gravitation, is one of the basic assumptions of Newtonian Mechanics. This does not appear to conflict with the fact that we can think instantly and simultaneously about phenomena no matter how far apart from one another in space and/or in time. However, absolute space is also a basic assumption of Newtonian mechanics. And it is supposed to contain absolutely everything that may exist in Creation, be it in the past, present or future. Consequently, it is supposed to contain, among others, the physical body of the thinking scientist as well. Yet it is not equally clear whether it also contains scientific thinking itself which, traditionally, is assumed to be totally outside and independent of all phenomena under its consideration, therefore in particular, totally outside and independent of the Newtonian absolute space, and perhaps also of absolute time.

And then the question arises : where and how does such a scientific thinking take place or happen ?

3.2. Within Einstein's Mechanics. In Special and General Relativity a basic assumption is that there cannot be any propagation of action faster than light. Yet just like in the case we happen to think in terms of Newtonian Mechanics, our thinking in terms of Einstein's Mechanics can again instantly and simultaneously be about phenomena no matter how far apart from one another in space and/or time.

Consequently, the question arises : given the mentioned relativistic limitation, how and where does such a thinking happen ?

3.3. With Quantum Mechanics. Let us consider the classical EPR entanglement phenomenon, and for simplicity, do so in terms of quantum computation. For that purpose it suffices to consider double qubits, that is, elements of $\mathbb{C}^2 \bigotimes \mathbb{C}^2$, such as for instance the pair

$$
\begin{aligned}
|\,\omega_{00} > \; &= \; |\,0,0> + |\,1,1> \; = \\
&= \; |\,0> \bigotimes |\,0> + |\,1> \bigotimes |\,1> \; \in \mathbb{C}^2 \bigotimes \mathbb{C}^2
\end{aligned}
\tag{3.1}
$$

which is well known to be entangled, in other words, $|\,\omega_{00} >$ is not of the form

$$(\alpha|\,0> + \beta|\,1>) \bigotimes (\gamma|\,0> + \delta|\,1>) \in \mathbb{C}^2 \bigotimes \mathbb{C}^2$$

for any $\alpha, \beta, \gamma, \delta \in \mathbb{C}^2$.

Here we can turn to the usual and rather picturesque description used in Quantum Computation, where two fictitious personages, Alice and Bob, are supposed to exchange information, be it of classical or quantum type. Alice and Bob can each take their respective qubit from the entangled pair of qubits $|\,\omega_{00} >$, and then go away with their respective part no matter how far apart from one another. And the two qubits thus separated in space will remain entangled, unless of course one or both of them get involved in further classical or quantum interactions. For clarity, however, we should note that the single qubits which Alice and Bob take away with them from the pair $|\,\omega_{00} >$ are neither one of the terms $|\,0,0 >$ or $|\,1,1 >$ above, since both these are themselves already pairs of qubits, thus they cannot be taken away as mere single qubits, either by Alice, or by Bob. Consequently, the single qubits which Alice and Bob take away with them cannot be described in any other form, except that which is implicit in (3.1).

Now, after that short detour into the language of Quantum Computation, we can note that, according to Quantum Mechanics, the entanglement in the double qubit $| \omega_{00} >$ implies that the states of the two qubits which compose it are correlated, no matter how far from one another Alice and Bob would be with them. Consequently, knowing the state of one of these two qubits can give information about the state of the other qubit. On the other hand, in view of General, or even Special Relativity, such a knowledge, say by Alice, cannot be communicated to Bob faster than the velocity of light.
And yet, anybody who is familiar enough with Quantum Mechanics, can instantly know and understand all of that, no matter how far away from one another Alice and Bob may be with their respective single but entangled qubits.

So that, again, the question arises : how and where does such a thinking happen ?

And one quite clear answer to all such questions is that :

- As far as the Archimedean perception and conception of space is concerned, such thinking does not much seem to happen or take place anywhere at all ...

And in case, it does not in fact happen "outside of space", then quite certainly, it must happen "outside of time", or at least, outside of the usual Archimedean perception and conception of it. After all, as mentioned above, Relativity alone would simply not allow it to happen anywhere in space-time ...
Thus, quite likely, we are back to some variant of the Cartesian "res cogitans" ...
No wonder, therefore, that modern Theoretical Physics does its best to avoid such issues ...

4. Possible Varieties of Indirect Contact ...

Let us start with what may appear as the simplest situation, namely, when two entities A and B are in contact with a third entity X in the following manner : X is aware of both A and B, but neither A, nor B is aware of the other two.
This situation may nevertheless constitute a certain indirect contact between A and B, since X may in some ways affect B, ways depending in part on A, and similarly, X may affect A in ways depending in part on B.

An obvious, and rather unsettling, feature of such an instance of indirect contact is that the two entities A and B may be involved in it without ever realizing it. In particular, in case X happens to be a suitable enough realm for such a possibility, it may easily turn out that A produces some, so to say, resonances in X which affect B to some extent, and/or a similar effect may propagate from B to A.

A remarkable feature of such a kind of indirect contact between A and B is that nearly all the requirements for the respective contact are on the third party X, rather than on the two assumed contactees A and B.

The practical implication for us, terrestrial beings on Planet Earth, of the above kind of indirect contact is that, in fact, we may have for ages by now been involved in certain instances of it without any awareness about it, and of course, we may continue to do so in the future ...

And as far as non-Archimedean space-time structures are concerned, such an indirect contact could possibly happen between A and B when, for instance, in their own terms, they belong to two walking worlds where one is infinitesimal with respect to the other, or the two are removed from one another by an infinitely large distance.

However, such indirect contact can easily happen even when A and B are in the same walkable world but they are not aware of one another, while on the other hand, the third party X is observing both of them, without A or B becoming aware of that.

Needless to say, the above minimal conditions on A and B for an indirect contact between them is to a certain extent natural. Indeed, a more direct contact may require suitable qualifications from A and/or B. Consequently, there may be a considerable variety of less indirect and/or more direct kind of contacts between A and B, and such contacts - with or without the involvement of third parties X - may be the subject of subsequent studies.

References

[1] Pushkar Ganesh Vaidya : Cosmic Contact Censorship. arXiv:physics/0702172

[2] Rosinger E E : Comments on a recent item by Yu I Manin. arXiv:math.GM/0703547

[3] Rosinger E E : String Theory : a mere prelude to non-Archimedean Space-Time Structures ? arXiv:physics/0703154

[4] Rosinger E E : Part I of this paper.

[5] Rosinger E E : Where and how does it happen ? arXiv:physics/0505041