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ONTOSEMANTIC DIVERGENCE AND COMPARABILITY OF THEORIES*

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Abstract
In this paper it is assumed that pairs of (not trivially) incommensurable theories are in fact comparable. This point of view leads us to accept that incommensurable theories deal with shared portions (chuncks) of the world. Ontosemantic conditions of comparability between two incommensurable theories are considered along the paper.

Introduction

Ever since Kuhn and Feyerabend formulated, separately, the incommensurability thesis in 1962 (cf. [9] and [3]), one of the reiterated criticisms of this thesis has been based on the idea that incommensurability between two theories entails their incomparability. Nevertheless, both, in different places, have pointed out that they consider that pairs of (not trivially) incommensurable theories are in fact comparable (cf. [9], pp. 198-202; [10], §6; [11]; [4], pp. 213-215; [5], p. xi). Furthermore, both have come to agree on the idea that the thesis is of an ontosemantic nature. Nevertheless, neither of them has gone as far as to specifically state what ontosemantic conditions assure the comparability of such a pair of theories. The aim of this work is to reconsider this matter, assuming that comparing (non-trivially) incommensurable theories leads us to assume that they deal, in some manner, with shared chunks of the world. However, this may seem a shade paradoxical: how can it be understood that two theories deal with shared portions of the world if they are incommensurable? Specifically stating the ontosemantic conditions of comparability between two incommensurable theories is the same as giving sense to the fact that they share these portions. I

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will start by dealing with this matter considering an initial version of the incommensurability thesis.

1. Incommensurability and characteristic terms

VERSION I OF THE THEORY OF INCOMMENSURABILITY

Two theories, *T* and *T'*, are incommensurable if and only if,

1. *T* and *T'* are *alternative* theories, as they have in common certain chunks of the world as an application setting;
2. *T* and *T'* are comparable;
3. the meanings of the *characteristic* terms of *T* are not expressible by means of the linguistic apparatus of *T'* and vice versa (in particular, when there are *characteristic* terms common to *T* and *T'*, these do not share the meanings: a change in their meanings is produced);
4. the references designated to the characteristic terms of *T* are not designatable by the linguistic apparatus of *T'* and vice versa (in particular, when there are characteristic terms common to *T* and *T'*, these do not share references: a change in their references is produced);
5. (consequently,) there is no translation, nor is there the possibility of reduction by the logical deduction of one of the theories to the other, for example from *T* to *T'*.

In version I it is admitted that the respective application settings of the incommensurable theories *T* and *T' actually* have something in common. But this seems implausible if there is variance in the meanings and references of the respective terms, if the respective conceptualisations report different "worlds". The problem lies in what should be understood by "having certain chunks of the world in common (for incommensurable theories)". An acceptable solution must show that it is not paradoxical to talk of pairs of theories *that are not translatable* and *between which there is a change of reference* and which, nevertheless, *share chunks of the world*.

In order to start, I would like to point out that conditions 3 and 4 of this version are established for *characteristic* terms of the theories taken into consideration. But what are characteristic terms? By characteristic terms of a theory I understand those descriptive terms that appear in the formulation of their laws. These express the specific manner in which the theory conceptualises the chunks of the world which it deals with. They are essential for the theory. Furthermore, I assume that the set of characteristic terms for a theory *T* is dichotomised into theoretical and non-theoretical ones relative to *T*, in the sense outlined by Hempel (in an intuitive formulation) and by the structuralist conception of metascience (in a more rigorous formulation[1]) (Cf. [7] Ch. 6; [8]; [2], pp. 50 on and 391 on).

2. Local incommensurability and local holism

In any case, when establishing conditions 3 and 4 of version I it is left undefined whether the ontosemantic divergence reaches *all* the characteristic terms of the incommensurable theories, or only *some* of them. In this respect, it is not a bad idea to recall that in his last works Kuhn came to defend that his proposal for incommensurability is local. Thus in “Commensurability, Comparability , Communicability” (1983) he establishes:

> “The claim that two theories are incommensurable is more modest than many of its critics have supposed.” ([11] p. 671)

And, he continues saying:

> “I shall call this modest version of incommensurability ‘local incommensurability’. Insofar as incommensurability was a claim about language, about meaning change, its local form is my original version.” ([11] p. 671)

According to this, it would seem to be that the variance of meaning and of reference between the two given incommensurable theories would not reach all the descriptive terms of the linguistic formulations of the rival theories, rather only some of them. It should be noted that it would not reach all the descriptive terms, not only the characteristic terms. Nevertheless, even limiting ourselves to the characteristic ones, it does not seem that this matter can be elucidated *a priori*, in the sense that this variance always reaches all of the characteristic terms or in that it always reaches only some of them. It would seem prudent to think that both possibilities are feasible. Obviously, the fact that it reaches less or more characteristic terms conditions whether incommensurability will be more local or less local, respectively. It could even be

[1] Here I refer to what can be called a “pragmatic or informal criterion of theoreticity” from the structuralist conception. I do not refer to so called “formal criterion of theoreticity” from the same conception.

considered whether, as far as divergence reaches all the characteristic terms, there would not be cases of global incommensurability. Kuhn himself appears to bear this doubt in mind, as is shown by the fact that in the same 1983 text, after proposing local incommensurability, he goes on to say:

> "It is not clear, however, that incommensurability can be restricted to a local region.... ....It is simply implausible that some terms should change meaning when transferred to a new theory without infecting the terms transferred with them." ([11] p. 671)

I would say that I consider that even when the variance of meaning and reference between (non-trivial) incommensurable theories reaches all the characteristic terms of both of them, there is still a shared non-characteristic descriptive vocabulary that assures compatibility, but not translatability between these theories. Accepting this means that in any case (non-trivial) incommensurability of theories is not global in the sense that it will be between two radically different languages, rather more or less local. At any rate, limiting ourselves for the moment to the characteristic terms of an empirical theory, we could ask ourselves whether there is some criterion for delimiting these terms that may be relevant when establishing the minima for (non-trivial) incommensurability, being assumed that the maximum is given by the variance of meaning and reference of the totality of characteristic terms for each one of the theories in competition. In this respect, we should bear in mind that Kuhn presents local incommensurability as a consequence of local semantic holism, according to which certain terms of a theory take their meaning and reference jointly, and thus one should learn to use them together and not in isolation. The question is now reconsidered in the sense of what the minimum group of terms that the local holism of a theory reaches is. In order to give a reasonable reply to this question, we are going to base ourselves on the distinction given by the structuralist conception between theoretical and non-theoretical terms relative to each theory. The distinction is based roughly on that, given a theory *T*, the referential values assignable to its non-theoretical terms can be determined by means of operational procedures that do not assume the laws of *T*, whilst those that are assignable to the theoretical terms of *T* can only be determined by assuming the fundamental laws of *T* - together with some specialised law(s), although this (or these) may vary for different applications - (Cf. [6], §4). In accordance with the distinction thus established, from those characteristic terms of a theory

T, the *T*-theoretical ones are those that inexorably depend on the fundamental laws of *T* and, therefore, those that have to be taken jointly in relation to *T* in order to be able to determine its values, and, we should add, in order to establish its meaning and reference (as well as to be learnt by those who start to study the theory). In the case of each *T*-non-theoretical term we find that it is possible to determine its values independently of the laws of *T*, since they can be obtained by means of operational procedures that are dependent on underlying theories, due to which its meaning and reference do not essentially depend on *T* either.

But, as has already been pointed out, variation of meaning and reference between (non-trivial) theories may also reach their respective theoretical terms. Nevertheless, even in these cases, it is possible to differentiate methodologically between a certain theory and its underlying one**.** When one theory *T* is incommensurable with respect to another one *T'*, not only in relation to its theoretical terms, but also in relation to its non-theoretical ones (or at least some of these), we can say, in accordance with the previously given methodological distinction, that incommensurability is established not only between *T* and *T'* but also between their underlying theories (or at least between some of them). A case of this type corresponds to the special relativity in relation to classical mechanics, in which besides the incommensurability between these two theories we can also find incommensurability between underlying theories such as that which arises between Minkowski's space, on one hand, and Euclidean geometry and classical chronometry, on the other, or such as that which - consequently - arises between relativist kinematics and classical kinematics.

The previous point of view, even when it has not been explicitly assumed by Kuhn in relation to his considerations on local incommensurability and local holism, can, I believe, be defended as not being beyond his line of thought. In support of this affirmation, we should bear in mind that in "Commensurability, Comparability and Communicability" (in the context of setting out that there is no translation between incommensurable theories, only interpretation, as there are a series of terms in any theory that are interrelated amongst themselves in such a manner that they need to be acquired jointly) Kuhn, touching on the example of Newtonian mechanics, establishes that the terms "mass" and "force" are the ones that are jointly acquired in this theory and, furthermore, are governed by the second law of Newtonian mechanics (cf. [11] pp. 676 on). According to the criterion of theoreticity of the structuralist conception, the terms "mass" and "force" are the only theoretical terms of Newtonian mechanics, and in the analysis of this view the fundamental law of this theory is the Newton's second law.

But, as if this did not seem enough, we should point to the mention made by Kuhn in the same context to the “Ramsey enunciation” and of its special use by the initiators of the structuralist view, J. Sneed and W. Stegmüller (cf. [11], pp. 678-679); it should be said that this use is based precisely on the distinction between theoretical terms and non-theoretical terms that is relativised to each theory. Kuhn later went on to affirm that the considerations that he formulated, regarding the inter-relation of the terms “mass”, “force” and “weight” in Newtonian mechanics, were suggested by Sneed and Stegmüller’s analyses for the formalisation of physical theories, and especially by their manner of presenting theoretical terms (cf. [12] note 13).

Thus the previous considerations enable us to establish that incommensurability between theories is produced by variance of meaning and of reference that affects *some* of their respective characteristic terms, at least their respective theoretical terms. The previous commentaries give occasion for formulating a new version of the theory of incommensurability. The new version will have to consider the reference to local holism.

VERSION II OF THE THEORY OF INCOMMENSURABILITY

Two theories *T* and *T'* are incommensurable if and only if:

1. *T* and *T'* are *alternative* theories between themselves, as they have in common certain chunks of the world as an application setting;
2. *T* and *T'* are comparable;
3. the meaning as of *some characteristic* terms of *T'* cannot be expressed by means of the linguistic apparatus of *T* (at least the theoretical ones relative to the other theory, at most, all the characteristic terms) and vice versa [as a specific case, when *these characteristic* terms are common to *T* and *T'*, they do not share meanings: a change in their meanings is produced];
4. the reference designated by some characteristic terms of *T'* cannot be designated by means of the linguistic apparatus of *T* (at least the *T*-theoretical ones, at most, all the characteristic terms) and vice versa [as a specific case, when the former characteristic terms are common to *T* and *T'*, they do not share references: a change in their references is produced];
5. (consequently,) there is no translation, nor is there the possibility of reduction by the logical deduction of one of the theories to the other possible, for example *T* to *T'*;
6. ontosemantic divergence between *T* and *T'* is a consequence, *at least*, of the dependence that *some characteristic* terms, the T-theoretical

and the *T'*-theoretical ones, have on their theory, directly on their fundamental laws (local holism).

The reason for cautiously affirming in 6 that "it is a consequence of *at least*…" is due to, as has been mentioned, nothing ruling out that, together with the ontosemantic divergence due to the variance of meaning and reference of the theoretical terms of the incommensurable theories, there may also be ontosemantic divergence due to the non-theoretical terms, or at least some of these.

The last version formulated includes a type of local holism according to which *at least* the ontosemantics of the theoretical terms (relative to a specific theory) is set simultaneously, and this is basically determined by the fundamental laws (in the structuralist sense) of a theory, as Kuhn has repeatedly pointed out and the structuralists have defended[2]**.** (cf. for example, [13] and [15] p. 195). On assuming this fact, it is accepted that modifications in the most basic or elementary laws, which would arise in theories underlying and given theory *T*, are *not essential* in order for there to be incommensurability; being understood that when modifications of this type appear in basic laws, they are nothing more, nor nothing less, than modifications to fundamental laws of some theory (or theories) underlying the given theory. It is clear that this type of modification in fundamental laws of theories underlying a given theory *T* generates one or more incommensurable theories to one or more of the theories underlying *T*. In order that this theory (or these theories) that are incommensurable to a theory (theories) underlying *T* become fully relevant for empirical science it seems that the formulation of a theory *T'* alternative to *T*, that is compatible with the one(s) that is(are) incommensurable to the underlying theories of *T*, is required.

An example that illustrates the above is given by non-Euclidean geometries that are incommensurable to the Euclidean one, the latter being one of the underlying theories of classical mechanics. Even though non-Euclidean geometries started to be considered before the formulation of special relativity, they did not take on any relevance for physics until the theory of special relativity was developed as an alternative to

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[2] Although the structuralists would add to the fundamental laws certain constraints and certain intertheoretical links that we could also call "fundamental". This is the point of view that I take. Moreover, I understand that these elements are the ones that form the "conceptual scheme" of a theory. If this last point is true, the well-worn notion of "conceptual scheme" would take on a precise and restricted sense for a theory, which would distance it from the excesses of radical holism and its use for justifying *relativist* points of view.

classical mechanics, requiring the special relativity of these geometries that are alternative to the Euclidean one.

In another manner of things, it is clear that with the type of holism assumed, it is ruled out that any type of change in a theory has to provoke incommensurability; not just any change in a theory leads to variance in the meaning and reference in the sense considered with the theory of incommensurability. Only to the degree in which there may be modifications to the fundamental laws of a theory *T* - or also of those of some of the underlying theories[3] -will there be phenomena of incommensurability. Mere changes to special laws in a theory will not generate phenomena of incommensurability.

3. Some elements of the structuralist metatheory

Recapitulating a little on the steps followed since the formulation of Version I of the theory of incommensurability, our aim of clarifying conditions 3 and 4 of that version led us to a new version that revises the previous one on the basis of the distinction, relative to each theory, between theoretical and non-theoretical characteristic terms, and on the consideration of a sort of local holism. Let us now return to the matter related with the explanation of the notion of "chunks of the world in common (with incommensurable theories)", but now from a new perspective that the previous considerations open up for us, and basing ourselves on structuralist metatheory.

Let us now start by explicitly stating the elements of this metatheory that we are going to need. Given a theory *T* whose basic characteristic terms[4] (in a particular formulation that is considered standard) will be $\underline{D}_1, ..., \underline{D}_k, \underline{s}_1, ..., \underline{s}_m, \underline{t}_1, ..., \underline{t}_n$, it is clear that this vocabulary can be interpreted by different appropriate systems, i.e., different possible realisations - in the Tarskian sense - or potential models (such that each $\underline{D}_i$, $1 \leq i \leq k$, designates a base domain, empirical in some possible realisations, and is *T*-non-theoretic; each $\underline{s}_i$, $1 \leq i \leq m$, is a *T*-non-theoretical function term; each $\underline{t}_i$, $1 \leq i \leq n$, is a *T*-theoretical function term)[5]. We will say that a possible realisation *x* of *T* is a structure

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[3] In cases of homography (and homophony) this usually has to do with modifications that affect the formal conditions of some characteristic terms.

[4] Characteristic terms that are definable from the basic ones are not included.

[5] For reasons of simplicity, expressions designating auxiliary domains of numeric entities are left out, and neither are T-non-theoretical ant T-theoretical relational expressions (that are not function terms) contemplated. On the other

$<D_1^x,...,D_k^x,A_1^x,...,A_l^x,s_1^x,...,s_m^x, t_1^x, ...,t_n^x>$ (where each D_i^x, 1≤i≤k, is a base domain; each A_i, 1≤i≤l, is an auxiliary domain of numeric entities[6]; each s_i^x, 1≤i≤m, and each t_i^x, 1≤i≤n, are functions that are generated according to set-theory on the base and auxiliary domains). In a similar manner, for *T'* we will have the characteristic terms $\underline{D}'_1$, ..., $\underline{D}'_p$, $\underline{s}'_1$, ..., $\underline{s}'_r$, $\underline{t}'_1$, ..., $\underline{t}'_s$; and a possible realisation *y* of *T'* is a structure $<D'_1{}^y,...,D'_p{}^y,A'_1{}^y,...,A'_q{}^y,s'_1{}^y,...,s'_r{}^y,t'_1{}^y, ...,t'_s{}^y>$. The set of *potential models* of *T* is represented by *Mp.* If we cut off the extensions of the theoretical terms of a potential model *x*, we obtain the corresponding non-theoretical substructure *z*, which is called a partial potential model. The set of *partial potential models* of *T* is represented by *Mpp*. The potential models that satisfy the laws of the theory are denominated *models*, and are represented by *M*, where $M \quad Mp$. But the empirical theories do not only establish restrictions by means of (proper) laws in order to determine which potential models satisfy these laws, rather they also require the fulfilment of certain conditions of compatibility amongst different potential models[7]; each one of these compatibility conditions selects certain combinations of potential models. Each selection of combinations of potential models for a compatibility condition is called a *constraint* and is represented by *C*, where $C \quad \wp(Mp)$, $C \neq \emptyset \quad C$ and $\quad x(x \quad Mp \rightarrow \{x\} \quad C)$[8]. As far as there are different compatibility conditions for the characteristic notions of a theory, we will make use of different constraints whose intersection will furnish us with the global constraint of the theory, that is represented by *GC.* We can say that the formal structure of the theory, i.e., everything that is defined by its lawlike sentences - expressing laws and other restrictions - corresponds to the theory-core, which is represented by *K*, where $K=<Mp, M, Mpp, GC>$[9].

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hand, it would seem normal to assume the terms of empirical domains of a theory *T* are always T-non-theoretic.

[6] The terms for the auxiliary domains are not descriptive, for this reason they are not included when stating the characteristic terms.

[7] For example, amongst potential models of classical mechanics, that the mass of a particle does not vary or when a potential model contains a particle p_1 that is a combination of two particles p_2 and p_3, the mass of p_1 should be different from the sum of the masses that is assigned to p_2 and p_3 in other potential models.

[8] Furthermore *C* is normally transitive, i.e., $\quad X \quad Y (X \quad C \quad Y \quad X \rightarrow Y \quad C)$.

[9] Here, for reasons of simplicity, one component of *K* is left out, namely, the

But a theory, as far as it is empirical, must have another component that determines that it does not aim to deal with any abstract system, rather with empirical systems. This component is a set of systems that can only be determined by means of strictly pragmatic criteria, and not in a formal manner like the others; this is the set of empirical systems that the theory is intended to be applied to. The latter component is denominated *intended applications* and is represented by I, where the intended applications are understood as substructures which are adapted to the non-theoretical conceptual apparatus, i.e., $I \quad Mpp$. In this manner we have that $T=<K, I>$, or, which is the same, that $T=<Mp, M, Mpp, GC, I>$. The *theoretical content* of T, $Cn_{th}(T)$ is given by the set of potential model combinations that satisfy the compatibility conditions and the laws of T, i.e., $Cn_{th}(T)=GC \cap \wp(M)$. When we cut off the extensions of the theoretical notions in the potential models of the combinations of $Cn_{th}(T)$, we obtain the set of potential partial model combinations whose expansion to potential models satisfies the theoretical content of T. It is said that this latter set constitutes the empirical content of T, where if **r** is the function that cuts off the extensions of the theoretical notions in each potential model, **r*** is applied to sets of potential models and **r**** to sets of sets of potential models (in the two latter cases as a function that establishes the restriction on the corresponding potential models), then $Cn(T)=\mathbf{r}^{**}(Cn_{th}(T))=\mathbf{r}^{**}(GC \cap \wp(M))$. The interest of the theory lies in verifying whether the intended applications taken jointly are a combination that belongs to the so-called empirical content of T, i.e., if $I \quad Cn(T)$. This constitutes the empirical assertion of the theory T to be contrasted. In any case it is important to establish which is the largest subset of intended applications that belongs to the empirical content of T, i.e., which is the largest set of intended applications of T for which this theory is successful. I refer to these as *successful intended applications* of T.[10]

4. Ontosemantic connections that assure comparability of incommensurable theories

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one corresponding to essential links of the notions of T with those of other theories (or of the potential models of T with those of other theories).

[10] For comprehensive treatment of this metatheoretical approach cf. [2]. For reasons of simplicity, we have restricted the elemental notion of theory - "theoretical element", in structuralist jargon -, without taking more complex theoretical entities, such as "theoretical net", into consideration.

With the aforementioned elements, we will now examine different possibilities of ontosemantic divergence between theories, in order to establish: (a) how it makes sense of the idea of shared chunks of the world, and (b) the possibilities of the comparison of these theories on the basis of these shared chunks.

Case A. It is clear that if two theories T and T' only diverge in their theoretical conceptual apparatus, comparison will be possible if they share the non-theoretical conceptual apparatus - i.e., $Mpp=Mpp'$ - and thus will be able to share intended applications. Obviously, in the case that we are considering the shared intended applications are those that we can consider as chunks of the world that are common to T and T'. The ontosemantic nexus is given by the fact that they share the respective non-theoretical terms. If T' displaces T, the reasonable outcome would be that the successful intended applications of T, would also be so for T'. That is to say, that if given a set I of intended applications of T, we have that one of its subsets I_S (where $\emptyset \neq I_S \;\; I$) is such that $I_S \;\; Cn(T)$ and $\;\; Y(Y \;\; I \;\; Y \;\; I_S \rightarrow Y \;\; Cn(T))$, thus these applications $I_S \;\; Cn(T')$ (obviously, $I_S \;\; I \cap I'$). Furthermore, we could talk of progress if T' had additional successful applications to those of I_S, specifically if these are already considered to be intended applications for T (it should be noted that in this case they would not be successful for T)

Case B. A more unusual situation would be that in which, *T and T'* diverging in the theoretical conceptual apparatus, we had $Mpp=Mpp'$, $I=I'$ and the successful intended applications were the same. If, furthermore, $Cn(T)=Cn(T')$, we would have a case of strict empirical equivalence. More exactly, in this case we would not be able to say that one of the theories is superior in the resolution of empirical problems, although it could be established which has strictly theoretical-formal advantages.

But the cases mentioned are too simple. The divergence of meaning and reference would only affect the relative theoretical terms of the two rival theories. It could be said that this divergence is too local, and that comparability is easily assured. But what happens if divergence also reaches the non-theoretical terms? Even when there is also divergence in the non-theoretical apparatus, there are various possibilities for understanding that two theories in competition deal with shared chunks of the world.

Case C. One of these cases would be given by the existence of an actually determinable relation between the partial potential models of the theories under consideration, T and T', such that it assures a relation between its respective intended applications I and I'. We say that ν is such a relation between partial potential models of T' and T, ν $Mpp' \times Mpp$, such that Dom(ν)=Mpp' and Rge(ν)=Mpp[11] and ν assures that $y'\ y(y' \in I' \rightarrow y\ \ I\ \ \ <y',y>\ \ \nu)\ \ \ \ y\ y'(y\ \ I \rightarrow y'\ \ I'\ \ \ <y',y>\ \ \nu)$; that is to say, a restriction of ν to the intended applications of T and T' assures the relation between these intended applications in such a manner that to each intended application of T' there corresponds at least one intended application of T, and to each intended application of T there corresponds at least one of T'.[12] The comparison requires us to establish whether one of the theories is more successful than the other with its intended applications. In order to establish this with precision we require a relation ν*, of a higher order than ν, between the potential sets of the partial potential models of T' and T, $\nu^*\ \ \ (Mpp') \times\ \ (Mpp)$, such that $\nu^* = \{<U,W>/\ \ \ u(u\ \ U \rightarrow\ \ w(w\ \ W\ \ <u,w>\ \ \nu))$ $w(w\ \ W \rightarrow\ \ u(u\ \ U\ \ \ <u,w>\ \ \nu)\}$. The relation ν* thus pairs off subsets of Mpp with subsets of Mpp', so that all the elements of the matched subsets are related by means of ν. If T' is more successful than T with the respective related intended applications, the result will be that:

(1) $Y'\ \ Y(\varnothing \neq Y'\ \ I'\ \ \ \varnothing \neq Y\ \ I\ \ \ <Y',Y>\ \ \nu^*\ \ \ Y\ \ Cn(T) \rightarrow Y'\ \ Cn(T'))$

and

(2) $Y'\ \ Y(\varnothing \neq Y'\ \ I'\ \ \ \varnothing \neq Y\ \ I\ \ \ <Y',Y>\ \ \nu^*\ \ \ Y'\ \ Cn(T')\ \ \ Y\ \ Cn(T))$.

That is to say that for each successful intentional application of T, those that are related in T' by means of ν will also be successful for the latter theory, and, moreover, T' has successful applications such that those related to those in T by means of ν are not successful for the latter theory. In this situation it would seem reasonable to opt for T' as opposed to T. But the very fact that (2) was fulfilled when the successful set of intended applications of T' was significantly greater or of greater

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[11] Given a relation δ, Dom(δ)=$\{x'/\ \ x(<x',x>\ \ \ \delta)\}$ and Rge(δ)=$\{x/\ \ x'(<x',x>\ \ \ \delta)\}$.

[12] Between the respective intended applications a bijection that identifies them is not required, since these are not strict real systems, rather representations of them; rather we would say that each real system would be represented by a class of equivalence of intended applications of a given theory, in such a manner that each intended application of T' can be related with various ones of T by means of ν, and vice versa.

importance than that of T, would already be a reason for taking T' into consideration. In the case of T and T' having the same degree of success with the respective intended applications, the result would be:

(3) $Y' \;\; Y(\emptyset\neq Y' \;\; I' \quad \emptyset\neq Y \;\; I \quad <Y',Y> \;\; \nu^* \rightarrow (Y \;\; Cn(T) \leftrightarrow Y' \;\; Cn(T')\,))$.

Case D. Nevertheless, a stronger condition can be satisfied, namely, that T and T' have an empirically equivalent content, that is, equivalent potential success, i.e.,

(4) $Y' \;\; Y(\emptyset\neq Y' \quad \emptyset\neq Y \quad <Y',Y> \;\; \nu^* \rightarrow (Y \;\; Cn(T) \leftrightarrow Y' \;\; Cn(T')\,))$.

This condition (4), together with those already established for ν and ν^* and the one of which $y' \;\; y(<y',y> \;\; \nu \rightarrow (y' \;\; I' \leftrightarrow y \;\; I))$, corresponds to a more flexible version of empirical equivalence than the one previously qualified as strict (Case B).[13]

Case E. It is possible to consider a relation that is actually determinable, between the respective partial potential models of T and T', $\zeta \;\; Mpp'\times Mpp$, which is weaker than the one that ν establishes above, if we only require that to every partial potential model of T there corresponds one from T', but not to that every potential model of T' there corresponds one from T, i.e., we ensure that Rge(ζ)=Mpp, but we do not demand that Dom(ζ)=Mpp'. Furthermore, this relation restricted to the intended applications of both theories only assures that $y \;\; y'(y \;\; I \rightarrow y' \;\; I' \quad <y',y> \;\; \zeta)$. Once again we need a relation ζ^* of a higher order than ζ between the potential sets of the partial potential models, $\zeta^* \quad (Mpp')\times \quad (Mpp)$, such that:

$\zeta^*=\{<U,W>/ \;\; u(u \;\; U\rightarrow \;\; w(w \;\; W \;\; <u,w> \;\; \zeta)) \quad w(w \;\; W\rightarrow \;\; u(u \;\; U \;\; <u,w> \;\; \zeta)\}$.

Comparison requires establishing whether one of the theories is more successful with regard to its intended applications related by means of ζ or whether they have the same degree of success regarding these intended applications. If they have the same degree of success, the following condition will be satisfied:

(5) $Y' \;\; Y(\emptyset\neq Y' \;\; I' \quad \emptyset\neq Y \;\; I \quad <Y',Y> \;\; \zeta^* \rightarrow (Y \;\; Cn(T) \leftrightarrow Y' \;\; Cn(T')\,))$.

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[13] In [2] Chapter 6 the authors present this last version as that of empirical equivalence of which there will rationally be instances. In fact, they give as an example of this type that of the empirical equivalence between Lagrangian mechanics and classical mechanics. Cf. pp. 284-295.

However, in this circumstance, there is nothing to rule out, T' being more globally successful, as far as it may have intended applications that are not related to those of T by means of ζ, given that there are partial potential models in T' that do not correspond with those in T.[14] Thus it is possible that T' will also be successful with a set of its intended applications that includes some that are not related to those of T, and hence will be globally more successful.

Case F. If for T and T' there is a ζ such as the one previously considered and (5) is not satisfied, then there are at least the following possibilities:

a) That regarding the intended applications related by ζ it will be the case that T' is more successful than T, i.e. the following are satisfied:

(6) $Y' \;\; Y(\emptyset\neq Y' \;\; I' \quad \emptyset\neq Y \;\; I \quad \langle Y',Y\rangle \;\; \zeta^* \quad Y \;\; Cn(T) \rightarrow Y' \;\; Cn(T'))$
and

(7) $Y' \;\; Y(\emptyset\neq Y' \;\; I' \quad \emptyset\neq Y \;\; I \quad \langle Y',Y\rangle \;\; \zeta^* \quad Y' \;\; Cn(T') \quad Y \;\; Cn(T))$.

In such a situation there would be reasons for opting for T':

b) That only (7) is satisfied, and (6) not so. The logical forms of (6) and (7) are identical to (1) and (2), respectively. Given the commentaries made for when only (2) is satisfied, it should not be surprising that the mere fact that (7) is given, when the successful global set of intended applications in T' was significantly greater or of more importance than that of T, would already seem to be a reason for preferring T'.

c) That with regard to the intended applications related by ζ it is the case that T is more successful than T', i.e., that the following are satisfied:

(8) $Y' \;\; Y(\emptyset\neq Y' \;\; I' \quad \emptyset\neq Y \;\; I \quad \langle Y',Y\rangle \;\; \zeta^* \quad Y' \;\; Cn(T') \rightarrow Y \;\; Cn(T))$
and

(9) $Y' \;\; Y(\emptyset\neq Y' \;\; I' \quad \emptyset\neq Y \;\; I \quad \langle Y',Y\rangle \;\; \zeta^* \quad Y \;\; Cn(T) \quad Y' \;\; Cn(T'))$.

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[14] It should be noted that the same cannot happen for T, since all partial potential models of this theory has some other ones that correspond to it in T' by means of ζ.

From the outset it would seem that if (8) and (9) arise, *T′* would have to be discarded; nevertheless, before proceeding in this manner it would have to be considered whether there is a set of intended applications of *T′* not related to those in *T* by ζ, such that this set is sufficiently significant (in number and importance) and for which *T′* were successful. This situation would be more difficult to evaluate if this last condition were satisfied. In any case, in such a situation there would be a good motive for attempting to overcome this by means of a theory made up of the successes of *T* and *T′*. Thus there would be a clear incentive to search for an alternative theory superior to *T* and *T′*.

Case G. This is a different case, one that is more flexible than those already taken into consideration, and it is considered in terms of there being an actually determinable connection between certain partial potential models of one theory and those of another, more specifically, between certain intended applications of one theory and those of another, even though there is no truly determinable connection between all those partial potential models of at least one of the theories with partial potential models of the other. This is a matter of establishing, in spite of non-theoretical (and theoretical) conceptual divergence, and of the generalised non-connectability of the *Mpp′*, that certain intended applications of one theory and ones of another theory are connectable, as they are related to shared chunks. In this case a comparison of both theories relative to the applications related in this manner can be established. The strong relativisation of comparison in this case means that its relevance would be subordinated to the relative size of the applications related in this way for each of the theories with regard to the total amount of the intended applications of this theory or to the applications thus related being given a great deal of importance for both rival theories. These matters go beyond the scope of this work. In any case, it would be possible to compare the theories relative to those of their intended applications which would be related in the manner considered.

But if we now ask ourselves what is required in order that a relation between intended applications of two theories, *T* and *T′*, whose non-theoretical terms diverge in meaning and reference (and thus so do the theoretical ones), guarantees that we are dealing with shared chunks, it seems clear that it is not enough to establish just any correspondence between the applications of one theory and another. The type of correspondence that interests us must not be artificial, merely formal or *ad hoc*. The type of correspondence that interests us requires that, even if there is divergence of meaning and reference between the terms that designate the base domains of the respective theories (and hence, between the base domains of their intended applications), we be able to establish that what these base domains correlated in this manner do is explicitly state in different manners the basic furniture of shared realities.

But it is clear that we must extend this consideration to those other cases in which relations such as the ν and ζ, considered above, aim to establish that two theories with divergence of meaning and reference between the respective base domain terms act on shared chunks. There must exist a bi-univocal relation between the base domains of those partial potential models - in their case intended applications - of *T* and *T′* which correspond to shared chunks.

It is worthwhile clarifying that, if *x* *Mpp* (of *T*) and *y* *Mpp′* (of *T′*), are two partial potential models (or specifically two intended applications) that correspond to a shared portion, the postulated relation between base domains does not need to be domain to domain. That is to say, for example, such that entities of another given domain of *y* correspond to the entities of a domain of *x*, or even that entities that are set-theory constructions from a single domain of *y* correspond to them. It could come about that relation be between one base domain and various base domains (and, perhaps, auxiliary domains) of *y*. Moreover, it is appropriate to point out that the idea of a relation between base domains was already formulated by Moulines in the context of explicitly stating requirements complementary to the notion of structuralist inter-theoretical reduction (cf. [14]; and [15], pp. 264-274). What is done here is to take this proposal in isolation from the relation of inter-theoretical reduction and apply it to the relation between non-theoretic substructures of two theories.

The prior mention of the structuralist inter-theoretical reduction relation gives the opportunity to make some considerations in its regard. Let us start by stating it explicitly. Basing ourselves on the previously established notions of the structuralist conception, it is clear that the relation is defined in the following terms: if *T* and *T′* are two theories, then ρ directly reduces *T* to *T′* (*T* ρ *T′*) if and only if (i) ρ *Mp′*×*Mp* and ρ is actually determinable; (ii) Rge(ρ)=*Mp*; (iii) *x′* *x*(*x′* *M′* <*x′*,*x*> ρ → *x* *M*)); (iv) *X′*(*X′* *GC′* → ρ*(*X′*) *GC*)); and (v) *y* *y′* *x* *x′*(*y* *I* → <*x′*,*x*> ρ r′(*x′*)=*y′* r(*x*)=*y* *y′* *I′*).[15]

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[15] ρ* (*Mp′*)× (*Mp*), such that ρ*(*X′*)={*x*/ *x′*(*x′* *X′* <*x′*,*x*> ρ)} .

It is as well to start by clarifying that some of the previously mentioned cases of relations between non-theoretical structures of two theories are compatible with the existence of the inter-theoretic reduction relation. Obviously, the existence of a reduction relation between *T* and *T'*, as defined above, implies a truly determinable relation between the respective partial potential models. The existence of a reduction relation permits a more direct comparison between the theories involved. However, the previous approaches show that the possibilities of comparing two theories with ontosemantic divergence are not restricted to those cases in which there is a reduction of one to the other. The mere existence of a relation of the type considered above between the respective non-theoretical structures of *T* and *T'*, without there being a reduction relation between these theories, enables their comparison. Due to this, the rational comparison of incommensurable theories is possible, even without there being a reduction of one of these to the other one.[16]

After this digression, let us now return to the point of the necessary relation between the base domains that we were dealing with. I had proposed the requirement of such a relation between base domains of respective (possible) intended applications of *T* and *T'*, with divergent basic ontologies, in order that it may be said that these (possible) applications correspond to the same chunk of the world. But it remains to be clarified what it is that enables us to establish this relation. It is a matter of this being justified with a certain degree of objectivity, i.e., intersubjectively, and as such, it depends on intersubjective procedures of dealing with the world. My point of view is that, to a certain degree, the reply was given by Kuhn, when he pointed out that incommensurability, as he conceived, is local. Declaring this means that in cases of incommensurability, in spite of ontosemantic divergence, there are descriptive terms that preserve their meaning and reference. Kuhn went so far as to point out the following:

> "The terms that preserve their meanings across a theory change provide a sufficient basis for the discussion of differences and for comparisons relevant to theory choice. They

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[16] I do not enter into the discussion of whether when there is an intertheoretical reduction it is possible to talk precisely of incommensurability. Although it is not assured that the reduction relation defined above implies strict translatability of the characteristic vocabulary of the reduced theory to the reducing one - nor, as such, strict deductibility of the laws of the reduced theory on the basis of the those of the reducing one -, it would seem that it supplies something very close to this translatability - and to this deductibility -. In this regard, see [16], [17] and [18], Chapter 1; [1]; [2], pp. 306 onwards.

> even provide [...] a basis from which the meanings of incommensurable terms can be explored." ([11] p. 671).

Not only does Kuhn make it clear that he understands incommensurability between theories as being limited to certain terms, but he also noted that it is the part of language whose terms have common meaning which supplies the basis for the comparison of these theories. According to Kuhn, comparison in these cases consists of an interpretative access (which has to be considered differently from translation), and it is the case that this interpretative access to an incommensurable theory is realised on the basis of shared language. Any possibility of objective ontosemantic connection requires having a shared background language available; otherwise, if we are dealing with two completely different languages, no objective ontosemantic connection will be guaranteed *between them*, since all links between them will consist of mere interpretations of the totality of one language from another.

We could say that whilst the case of two totally different languages faces us with the problem of indeterminacy of radical translation and of the total inscrutability of the reference, the case of incommensurable theories does not pose the problem of radical translation, rather it faces us with a local translation decision and partial inscrutability of the reference.[17] Language shared by theories that are incommensurable entails that interpretative access in only required from one theory to another - from the displacing one to the displaced one when there is supplantation of theories - in a limited part of the terms of the latter theory, although this is a central part in the linguistic formulations of this theory; this make it possible for connections to be established that are not merely interpretational. In the case of incommensurable theories, interpretative access between theories is based on shared language. But all this could seem to be in contradiction to our previous acceptance that divergence may reach the totality of the characteristic terms of a theory with regard to those of the rival theory. There is, however, no such contradiction if, besides all the characteristic terms, we assume that in the language of one theory there are non-characteristic descriptive terms.

Following Kuhn's opinion, we can say that ontosemantic connections between two incommensurable theories can be established, as, in spite of the variance of meaning and reference that affect certain char-

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[17] The "indeterminacy of translation" and the "inscrutability of reference" theses originated from the Quine's approach. For the former cf. [19] Chapter 2 and [20] Chapters 1 , 2 and 3; for the latter cf. [20] Chapter 2.

acteristic terms of the pairs of theories in question, there is a lot of language in common. Interpreting this opinion of Kuhn could affirm that even when ontological divergence is total between two incommensurable theories, the non-characteristic language is a shared language that enables us to establish that the respective ontologies touch upon common chunks of the world. This is understandable if we admit that each empirical theory conceives and represents the chunks which it deals with in accordance with its characteristic terms, and as such, sets the ontology which is dealt with by means of some of these terms, but also that this is not the only manner in which, from a particular theory, the application chunks are identified. Non-characteristic language supplies another manner of designating the chunks of the world which it deals with, a way of designating that it is not involved with the characteristic ontology of the theory, a manner of designating that it is accessible to the habitual user of the language, even though he does not know the theory in question. In fact, in the linguistic formulations of a theory (especially with didactic purposes) designations of chunks of the world that use characteristic terms, and those that employ non-characteristic terms are frequently used jointly, and it is established that the former constitutes the specific manner in which the theory deals with the chunks which atheoretically are designated by means of the latter ones. Those individuals not familiar with the theory connect their non-characteristic designations on certain chunks of the world with the particular form or conceiving these chunks according to the theory. This enables them to come to understand what the theory is dealing with and the manner in which it does so by using its characteristic terms. The non-characteristic language of a theory is shared by rival theories and supplies an ontosemantic connection between these theories, the bridge across which to establish their comparability, even if they are incommensurable.

It must now be borne in mind that the ontosemantic connections which give rise to the comparability of incommensurable theories, do not allow any translation of one of the theories to the other, as the characteristic terms of each theory are not definable in the shared non-characteristic language. Thus, the non-characteristic language of each one of the theories of a pair that are incommensurable between themselves, even if the language is shared by these theories, does not permit the translation of the characteristic of one to those of the other, and vice versa. Neither should non-characteristic language be thought of as an problematic language that enables us to describe the world in an objective manner. The distinction between characteristic and non-characteristic descriptive terms in (a given linguistic formulation of) a theory, which is previously assumed, should not be understood in the neopositivist sense of theoretical/observational. The aim is not that the non-characteristic vocabulary should play an epistemo-semantic role similar to that which the it was supposed corresponded to the so-called "observational vocabulary" in neopositivist analysis. Non-characteristic language is usually imprecise and scientifically unsatisfactory for reporting the world, although for the speakers of a language it is a useful common basis for dealing with the world on an everyday level. The non-characteristic terms, of a particular formulation, of the theory *T* make basic non-technical descriptions of its applications possible by means of a conceptual apparatus that is independent of the one that is particular to *T*. They are useful for supplying intuitive recognition, even if it is not sufficiently exhaustive or precise, of the applications of *T*; specifically, for laymen in the theory in question. But they are not essential for the theory. In a certain sense we could say that they give features of the applications that are irrelevant to the specific way in which *T* conceptualises them. It is true that the *T*-non-theoretical characteristic terms also serve to describe its intended applications, but they do so in the "technical" manner that is appropriate to the theory, and not necessarily in a manner that facilitates intuitive recognition of the applications.

One final consideration. In this proposal the connection between domains of respective (possible) intended applications - or partial potential models - of two theories with ontological divergence - connection assured by means of the non-characteristic language that these theories share - constitutes the condition that is necessary in order for there to be a bridge between these (possible) applications that assures that these touch upon shared chunks.

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