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# CARNAP, THE RAMSEY-SENTENCE AND REALISTIC EMPIRICISM*

ABSTRACT. Based on archival material from the Carnap and Feigl Archives, this paper re-examines Carnap's approach to the issue of scientific realism in the 1950s and the early 1960s. It focuses on Carnap's re-invention of the Ramsey-sentence approach to scientific theories and argues that Carnap wanted to entertain a genuine neutral stance in the realism-instrumentalism debate. Following Grover Maxwell, it claims that Carnap's position may be best understood as a version of 'structural realism'. However, thus understood, Carnap's position faces the challenge that Newman raised against Russell's structuralism: the claim that the knowledge of the unobservable is limited to its purely structural characteristics is either uninformative or unsustainable.

## 1. LIBERALISATION

By the early 1950s, empiricists have fully acknowledged that theoretical discourse has 'excess' or 'surplus' meaning. This idea is reflected in the standard empiricist way to represent a scientific theory: Carnap's "The Methodological Character of Theoretical Concepts" (1956) – henceforth *MCTC*. There, Carnap advances a general logico-linguistic framework $L$ in which scientific theories can be developed. The total language of science is divided into two sub-languages: an observational language $L_O$ which is completely interpreted, and a theoretical language $L_T$ whose descriptive vocabulary $V_T$ consists of theoretical terms. The variables of $L_O$ range over concrete observable things and their domain is finite.

The theoretical language $L_T$ is much richer: it contains a type-theoretic logic with an infinite sequence of domains $D^0$, $D^1$, $D^2$, ..., where $D^n$ is the domain of the $n$-th level.[1] Each variable and each constant belong to a definite level. $D^0$ comprises the infinite sequence $O$, $O'$, $O''$, ..., which can be thought of as the domain of natural numbers. Then the domain of each $D^{n+1}$ is the domain of all subclasses of $D^n$. $L_T$ contains the whole of classical mathematics, i.e., expressions and variables for all objects of classical mathematics.

Such strong language has a certain theoretical advantage: all physical concepts occurring in theories can be shown to be represented by

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elements of $D^i$. $L_T$ can accommodate a space-time co-ordinate system such that each space-time point is assigned a 4-tuple of numbers. Physical magnitudes are introduced as functions from space-time points (quadruples of numbers) to numerical values. Physical objects (e.g., a particle) are represented as four-dimensional regions inside which certain physical magnitudes have a certain distribution. Expressed within $L$, a scientific theory is a set $T$ of theoretical axioms (the so-called theoretical- or $T$-postulates) and a set $C$ of correspondence rules (or $C$-postulates) connecting the theoretical vocabulary $V_T$ with the observational vocabulary $V_O$. Theories have 'excess content' over their observational consequences precisely because they make full use of irreducible $T$-terms and postulates.

Based on some archival material and lesser known papers of Carnap's, this paper will concentrate on the following question: how can Carnap's liberalised empiricist approach to theories avoid commitments to theoretical entities? In Sections 2 and 3, we shall see that Carnap struggled a lot to articulate a position which is neither full-blown realist nor instrumentalist. He thought he found a satisfactory niche only after he re-invented and developed further the Ramsey-sentence approach to scientific theories (Sections 4 and 5). Carnap's final position is that empiricists who accept the Ramsey-sentence approach to theories disagree with realists over "meaning postulates" (Section 6). The last section (7) of the paper will show that this is false. It will also suggest that Carnap's endorsement of the Ramsey-sentence approach brings him very close to endorsing what Grover Maxwell called 'structural realism'. Alas, structural realism faces a damaging objection that the mathematician M. H. A. Newman first raised against Russell's (1927) structuralism: without suitable restrictions on the range of the variables of the Ramsey-sentence, a Ramsey-sentence understanding of theories renders trivial and *a priori* true all, apparently substantive, commitments to unobservable entities issued by scientific theories. But if such restrictions are imposed, then the structural realist thesis that only the *structure* of the unobservable world is knowable becomes unsustainable.

## 2. METAPHYSICAL VS EMPIRICAL REALISM

A few years before Carnap's *MCTC*, Herbert Feigl (1950) suggested that the new liberalised empiricism had nothing to fear from explicit commitments to theoretical entities. In a symposium published in *Philosophy of Science*, Feigl urges that in light of the fall of verificationism, the issue between empiricism and realism should be reconsidered. Once it is accepted that $T$-terms have 'excess content', then it is but a short step

to accept that $T$-terms have factual reference: they designate theoretical/unobservable entities. The so-called surplus meaning of $T$-terms is grounded in their factual reference. In its treatment of the meaning of theoretical terms, Feigl argues, verificationism has run together two separate issues: their "epistemic reduction (i.e., the evidential basis)" and "the semantical relation of designation (i.e., reference)" (1950, 48). Verificationism conflates the issue of what constitutes evidence for the truth of an assertion with the issue of what makes this assertion true, if it is true. But if these two are separated, then the question of the meaning of theoretical terms is answered once and for all. Regardless of whether one acknowledges a difference with respect to testability between observational and theoretical assertions, both kinds of assertion should be treated semantically on a par, that is as being truth-conditioned. This simply requires that theoretical terms, no less than observational ones, have putative factual reference. Feigl dubs this position "semantic realism" and urges that a full and just explication of the way the language of science is used can dispense with designata of theoretical terms no more than it can dispense with designata for observational terms.

Carnap enters this debate a few years later. His main position is that empiricism might be in danger if it accepts that theoretical entities are real. For wouldn't that be just another metaphysical claim? It is a central claim of the present paper that Carnap's own aim is to defend a sort of *genuine neutralism* with respect to the question of the existential implications of scientific theories: no existential commitments to unobservable entities are dictated by scientific theories, but scientific theories are not mere instruments for 'prediction and control' either, as strict instrumentalism would have it. But the pressing question is: can this neutral stance be achieved, while verificationism is abandoned and the 'excess content' of theories is asserted?

In his *MCTC* (cf. 1956, 44–45), Carnap suggests that there are two different kinds of existential question, and two senses of 'real' ("although in actual practice there is no sharp line between them"). Within $L_O$ claiming that a certain observable event is real is tantamount to claiming that a sentence of $L_O$ describing this event is true.

When it comes to $L_T$, the situation is more complicated. Questions concerning the reality of a specific event described in theoretical terms (e.g., questions about the reality of a particular configuration of electrons moving in a specified way) are treated like those in $L_O$: "to accept a statement of reality of this kind [i.e., the reality of an event described in theoretical terms] is the same as to accept the sentence of $L_T$ describing the event" (1956, 45). However, questions concerning the reality of a system of entit-

ies in general, e.g., of electrons in general, or of the electromagnetic field in general, are "ambiguous". But, Carnap adds, we can give them a good *scientific* meaning "if we agree to understand the acceptance of the reality, say, of the electromagnetic field in the classical sense as the acceptance of a language $L_T$ and in it a term, say '$E$', and a set of postulates $T$ which include the classical laws of the electromagnetic field (say, the Maxwell equations) as postulates for '$E$'. For an observer to 'accept' the postulates of $T$, means here not simply to take $T$ as an uninterpreted calculus, but to use $T$ together with specified rules of correspondence $C$ for guiding his expectations by deriving predictions about future observable events from observed events with the help of $T$ and $C$" (1956, 45).

Carnap masterly refrains from saying anything about the issue of factual reference of theoretical terms, although he acknowledges that $T$-terms have excess meaning, and that they contribute to the experiential output of the theory. He also distances himself from the strict instrumentalist view of theories which takes the theoretical 'superstructure' to be a merely syntactic construct. Yet, he seems keen to endorse double existential standards: assertions about observable events as well as assertions about *particular* theoretical entities are truth-valued and, if true, they imply certain existential commitments. But assertions concerning the reality of a system of entities as a whole are of a different kind. They should be understood as questions concerning the acceptance of a certain logico-linguistic framework.

The reader will note that Carnap's 'double existential standards' resonate with his external/internal questions distinction (cf. 1950[1956]). The reality of theoretical entities *as a whole* (e.g., electrons etc.) is a framework principle, while the reality of *particular* entities (e.g., of a certain configuration of electrons) is an empirical assertion which is being raised and investigated after the framework has been accepted.

I shall refrain from discussing the fact/framework distinction in this paper. I am willing to grant, for the sake of the argument, that the fact/framework distinction frees Carnap from unwanted metaphysical commitments.[2] What I want to show is that even if this distinction was granted, Carnap's neutralism would still face a problem. For suppose we do dismiss the so-called metaphysical aspect of the existence of theoretical entities as a pseudo-issue. Still, it seems that Carnap's empiricism should be happy with *internal* existential claims concerning physical unobservable entities. This is certainly a claim that instrumentalists would not accept. Hence, the alleged neutrality of Carnap's empiricism is betrayed. In sum, why isn't Carnap's position realist enough?

In order to highlight this query we need to focus on a different, but related, distinction that Carnap drew: the distinction between metaphysical and empirical realism. As Parrini (1994, 262) notes, in Carnap's early writings the distinction is depicted as follows. Claims of metaphysical reality pertain to traditional metaphysical questions of existence: do material objects exist in a mind-independent way or not? However, Carnap notes, one can dismiss such questions or issues and still wonder about the *empirical reality* of an object: is it real or is it an illusion, a dream, a construct etc.? This metaphysical/empirical distinction re-appears briefly in Carnap's later writings, too.[3] This time, though, Carnap's usage is motivated by Feigl's pleas to empiricists to adopt empirical realism. Feigl says: "The term 'real' is employed in a clear sense and usually with good reason in daily life and science to designate that which is located in space-time and which is a link in the chains of causal relations. It is thus contrasted with the illusory, the fictitious and the purely conceptual. The reality, in this sense, of rocks and trees, of stars and atoms, of radiations and forces, of human minds and social groups, of historical events and economic processes, is capable of empirical test" (1943[1949], 16). For Feigl, empiricism should go for empirical realism, and this position carries with it commitments to the empirical reality of scientific unobservables no less than to middle-sized material objects. Feigl's "semantic realism" had been suggested as "a corrected form and refinement of the empirical realism held by some logical positivists or empiricists" (1950, 50). Theoretical entities should be considered no less real than observable entities, given that "they are on a par within the nomological framework" of modern science. That's all empirical realism requires and, Feigl urges, that's perfectly sensible for empiricists to advocate. Having explicated what it is for an entity to be real, whether or not it should be considered to be real depends on whether or not this entity is an indispensable and irreducible element of the well-confirmed nomological framework of science.

Whatever else it does, empirical realism *does* imply strong enough realist commitments: understood from the empirical realist point of view, scientific theories imply commitments to unobservable entities no less than to observable ones. Besides, unobservable entities are said to exist independently of our capacity to gather direct evidence for their existence. Hence, their reality can be asserted, albeit the claim is empirical (in Feigl's sense) rather than metaphysical. And, for Feigl at least, not only is this a realist enough position, but also it is the way empiricism should go.

## 3. EARLY STRUCTURALISM

Although Carnap paid lip service to empirical realism, I think he did take his neutralist stance very seriously. To this end, he aimed to offer an empiricist account of scientific theories which did not imply commitments to physical unobservable entities. In order to support this thesis, I shall discuss briefly the way Carnap tackles the "problem of the admissibility of theoretical entities" in his *MCTC* (cf. 1956, 43–47).

Recall from Section 1 that Carnap's logico-linguistic framework $L$ has two types of variable. Those of $L_O$ range over observable events. But the variables of $L_T$ are taken to range over the domain $D$, which is the domain of classical mathematics. So, the variables of $L_T$ are taken to range over *mathematical entities*.

Carnap notes that this remark about variables ranging over natural numbers, classes of them etc. "should not be taken literally" but as a "didactic help" (1956, 45–46). But in the end, all this does not matter much to him. For him, the important feature of the denumerable domain $D^0$ of the language $L_T$ is that it has a "particular kind of structure, viz., a sequence with an initial but no terminal member" (1956, 46). This structure is isomorphic to the structure of natural numbers. Hence, the variables of $L_T$ range over the elements of a certain structure which is isomorphic to the structure of natural numbers. The natural numbers can conveniently be taken to be the domain of quantification of the variables of $L_T$. What really matters, though, is the *structure* of the domain of the theory, not its elements. As he puts it: "the structure can be uniquely specified but the elements of the structure cannot. Not because we are ignorant of their nature; rather because there is no question of their nature" (ibid.).

I take this to be a rather bold, if still vague, subscription to structuralism: what matters for the functioning of theories is the specification of the structure of the domain of $L_T$ and, therefore, of the theory *TC* which is couched in terms of $L_T$. Since classical mathematics is adequate for the representation of any physical concept, a theory *TC* is presented as exemplifying a certain logico-mathematical structure which gets connected with the observable world via *C*-postulates. For Carnap, once we get clear about the structure of the domain of the theory, the remaining questions about the kinds of entities designated by the theoretical expressions of *TC* lose their significance: we may take them to be mathematical entities (ultimately, natural numbers, classes of them, etc.) "as long us we are not misled by these formulations into asking metaphysical pseudo questions" (Carnap, 1956, 46).

Carnap's early structuralism emerges as an extension of his empiricism and seems to underscore his neutralism. Theoretical concepts are accommodated within the language of science. Their 'excess content' is guaranteed by the fact that they are not reducible to observational ones. But the appeal to structuralism seems to free Carnap from any explicitly realist account of the existential implications of scientific theories. More importantly, it seems to free him from any *internal* commitments to physical unobservable entities as the referents of theoretical terms. For it implies that what really matters is the logico-mathematical structure of the domain of the theory and not what the nodes in this structure may be.

## 4. CARNAP MEETS RAMSEY

Here starts a fascinating episode in the history of logical empiricism. In an attempt to substantiate his still vague structuralism and to defend his neutralism, Carnap re-invents the Ramsey-sentence approach, what he's called the *existentialised form of theories*. It was Hempel who pointed out to Carnap that all this had already been put forward by Frank Ramsey. Here is how Carnap states the episode (from a letter to Hempel; CA, 102-13-53).

"February 12, 1958.

"Dear Lante:

"In the last week I have thought much about you, your ideas, and writings, because I was working at the Reply to your essay for the Schilpp volume. On the basis of your article "Dilemma" I reworked a good deal of it and some new ideas came in. I think this article of yours is a very valuable work which helps greatly in clarifying the whole problem situation. Originally I read only §§6 and 7 because you had commented that they refer to my article on theoretical concepts. Unfortunately I postponed reading the remainder (and thus the last two sections) because I was too busy with other replies for the Schilpp volume.

The case of the Ramsey-sentence is a very instructive example how easily one deceives oneself with respect to the originality of ideas. At Feigl's conference here in 1955 [this is the Los Angeles Conference, S.P.], where Pap, Bohnert and others were present, I represented the existentialized form of a theory as an original recent idea of my own. Sometime after the Conference Bohnert said that he had now remembered having found this idea some years ago and having explained it to me in a letter to Chicago. Although I could not find that letter in the files, I had no doubt that Bohnert was correct, so I ceded the priority to him. He thought more about it and became more and more enthusiastic about this form and he even gave up his old thesis project (on dispositions) and developed new ideas how to use the existentialized form of the theory in order to clarify a lot of methodological problems in science; this he intended to work out as his thesis. Then, I believe it was last summer, when I read the rest of your "Dilemma", I was struck by your reference to Ramsey. I looked it

up at the place you referred to in Ramsey's book, and there it was, neatly underlined by myself. Thus there was no doubt that I had read it before in Ramsey's book. I guess that was in the Vienna time or the Prague time (do you remember whether we talked about it in Prague?). At any rate, I had completely forgotten both the idea and its origin" ( . . . ).

What is the existentialized form of a theory that Carnap refers to? In the protocol of the Los Angeles conference, Carnap is reported to have extended Craig's results to "type theory, (involving introducing theoretical terms as auxiliary constants standing for existentially generalised functional variables in 'long' sentence containing only observational terms as true constants)" (FA, 04-172-02, 14). He is also reported to have shown that "(a)n observational theory can be formed which will have the same deductive observational content as any given theory using non-observational terms. Namely, by existentially generalising non-observation terms" (cf. ibid., 19). There should be no doubt that, inspired by the Craig result, Carnap literally re-invented the Ramsey-sentence approach. But in writing his *MCTC* he made no use of it.

The first public announcement of Carnap's new views is his paper "Beobachtungssprache und Theoretische Sprache" ("Observation Language and Theoretical Language") which was published in German in *Dialectica* in 1958. This piece was not translated into English until 1975. Carnap was so thrilled with his new views that he published them in at least three more places, delivered lectures on them and conference addresses. All these were conducted in the same period, from 1958 to 1961, although some appeared as late as in 1966.[4]

Not that all these publications say exactly the same thing. In fact, their slight and more important differences alike reflect Carnap's attempt to understand and appreciate the full philosophical significance of the Ramsey-sentence approach and of the use to which it can be put. What is worth stressing is that Carnap found in the Ramsey-sentence approach a way to develop his structuralism and to articulate of his own neutralist empiricism.

## 5. STRUCTURALISM EXISTENTIALISED

In order to get the Ramsey-sentence ${}^{R}(TC)$ of a theory $TC$ we replace all theoretical constants with distinct variables $u_i$, and then we bind these variables by placing an equal number of existential quantifiers in front of the resulting formula. So, suppose that the theory $TC$ is represented as $TC(t_1, \ldots, t_n; o_1, \ldots, o_m)$, where $TC$ is a purely logical $m + n$-predicate. The Ramsey-sentence ${}^{R}(TC)$ of $TC$ is: $\exists u_1 \exists u_2 \ldots \exists u_n TC(u_1, \ldots, u_n; o_1, \ldots, o_m)$. For simplicity let's say that the $T$-terms of $TC$ form an $n$-tuple

$t = \langle t_1, \ldots, t_n \rangle$, and the $O$-terms of $TC$ form an m-tuple $o = \langle o_1, \ldots, o_m \rangle$. Then, ${}^{R}(TC)$ takes the more convenient form: $\exists u TC(u, o)$.

One can show that a sentence $S$ couched in the observational vocabulary follows from the theory iff it also follows from the Ramsey-sentence of the theory. Ramsey did not prove this, but Carnap did.[5] But what *exactly* does the Ramsey-sentence say? Ramsey himself says very little by way of explication (cf. 1929). He starts by noting that theories are used to express judgements, i.e., to make truth-valued assertions. But he adds that the latter pertain only to the "laws and consequences" of the theory, "the theory being simply a language in which they are clothed, and which we can use without working out the laws and consequences" (1929, 120). And, finally, he points out: "The best way to write our theory seems to be this $(\exists \alpha, \beta, \gamma)$: dictionary.axioms" (1929, 120), where $\alpha, \beta, \gamma$ stand for the propositional functions of the theoretical language (Ramsey's "the secondary system") (cf. 1929, 103).

I think Ramsey's insight is the following. From an empiricist perspective what really matters is the empirical content of the theory. Yet, in presenting a theory, one typically uses theoretical terms and predicates. But one need not treat them as names. This is not required for the legitimate use of the theory. One can simply treat the propositional functions (i.e., theoretical terms and predicates) of the theoretical language as genuine variables which are however bound by existential quantifiers so that the resulting construction is a sentence – as opposed to an open formula. Being a sentence, the resulting construction is truth-valuable. Hence, it can be used to express a judgement. However, the Ramsey-sentence $\exists u TC(u, o)$ of the theory implies more than the empirical content of the original theory: it implies that not all statements of the form '$u$ stands in relation $TC$ to $o$' are false, and hence it implies that $TC$ is realised. In other words, it implies that there are classes (and classes of classes etc.) of entities which realise the Ramsey-sentence. But the Ramsey-sentence does not commit one to the existence of some particular set of such entities. On Ramsey's view, the cognitive (i.e., truth-valuable) content of the theory is captured by its empirical content together with the abstract claim of realisation.

So, Ramsey suggests that the use to which a theory is put can be well captured by the weaker formulation $\exists u TC(u, o)$, instead of the stronger formulation $TC(t, o)$. To be sure, the weaker formulation goes beyond strict empiricism. But the entities which realise the Ramsey-sentence are to be taken purely existentially. What exactly these entities are is a separate issue, one that, Ramsey suggests, we don't have to deal with in order to use the theory and in order to understand what it says about the observable world (cf. 1929, 121). Ramsey is quite clear in taking the second-order

variables purely extensionally. He stresses: "Here it is evident that $\alpha$, $\beta$, $\gamma$ are to be taken purely extensionally. Their extensions may be filled with intensions or not, but this is irrelevant to what can be deduced in the primary system" (1929, 120).[6]

When it comes to Carnap's understanding of the Ramsey-sentence, it is important to stress that he attempts a reading of the Ramsey-sentence that can serve his neutralism. So, he takes it that theoretical terms are replaced by genuine variables which range over *whatever n-tuples of entities* may satisfy the Ramsey-sentence of the theory. Following Ramsey, he adopts an extensional understanding of the range of the variables which does not have them ranging over classes of theoretical entities (nor theoretical properties). Where the Ramsey-sentence says that there are non-empty classes of entities which are related to observable entities by the relations given in the original theory, Carnap suggests that we are at liberty to think of these classes as classes of "mathematical objects".

After the development of the Ramsey-sentence approach, in his *Dialectica* paper, Carnap still stresses that the theoretical language $L_T$ doesn't demand quantification over physical theoretical entities. $T$-terms can be thought of as designating *mathematical entities*, which, however, are physically characterised "so that they have the relations to the observable processes established by the $C$-postulates while simultaneously satisfying the conditions given in the $T$-postulates" (1958, 81).

By way of example, Carnap notes that the constant '$n_p$', defined as 'the cardinal number of planets', although descriptive, designates a natural number which belongs to the domain $D^0$. The number $n_p$ is identical with the number 9, yet the identity statement '$n_p = 9$' is synthetic: the world contributes in deciding whether it is true. Here Carnap does not assert the truism that descriptive constants can refer to mathematical objects. His point is that since to any (type of) descriptive theoretical constant of $L_T$ there corresponds an extensionally identical (type of) mathematical function, one can take the mathematical entities designated by these functions to be the extensions of the descriptive constants (cf. CA; Philosophical Foundations of Physics; Lecture XIV, 42).

To be sure, in more realistic cases we don't know what the extension of a descriptive constant is. For instance, take '$E$' to be a descriptive functor standing for the electric field vector. The statement $E(x_1, x_2, x_3, t) = (u_1, u_2, u_3)$ asserts that the value of the electric field at point $(x_1, x_2, x_3)$ at time $t$ is a triple of real numbers, which are the values of the components of the electric-field vector at that space-time point. We have no clue as to what the extension of this function is, as this would require us knowing the actual distribution of the electric field throughout space and time. What

we normally do is find the values of this function for particular set-ups or regions, e.g., the distribution of the field in a certain conductor. In any case, Carnap suggests, we do know that '$E$' is of a certain *logical type*: it is a function from quadruples of reals to triples of reals. Therefore, we know that there is a mathematical function $f$ which is extensionally identical with $E$, i.e., $E$ and $f$ have the same value for any argument: for any $x_1, x_2, x_3, t$, $E(x_1, x_2, x_3, t) = f(x_1, x_2, x_3, t)$. This is an identity statement, like the statement '$n_p = 9$'. Both statements, '$E = f$' and '$n_p = 9$', express an extensional identity between a descriptive constant and a mathematical one, and both are synthetic, too (cf. CA; Philosophical Foundations of Physics; Lecture XI, 40–41). Hence on Carnap's reading of the Ramsey-sentence, the existentially quantified variables do not range over physical unobservable entities but rather over mathematical entities. The 'excess content' of theories is that they characterise physically mathematical entities. Does this move secure Carnap's neutralism?

Not surprisingly, Feigl thought that Carnap advances some sort of "syntactical positivism". In a letter of 21 July 1958 to Carnap (CA, 102-07-06), Feigl exclaimed: "[W]e are taken aback by your 'syntactical positivism', i.e., mathematical interpretation of theoretical concepts in empirical sciences. We shall attempt more 'realistic' interpretation, – if this be metaphysics, make the least of it!".

In his reply of 4 August 1958 (CA, 102-07-05) Carnap admits that the formulations in the *Dialectica* paper "are really too short to give a clear picture of my view" and, for further clarification, he refers Feigl to his (Carnap's) reply to Hempel – "Hempel on Scientific Theories" – in the Schilpp volume. Yet, this piece is not more illuminating. There, Carnap notes that "the Ramsey-sentence does indeed refer to theoretical entities by the use of abstract variables". But he immediately adds: "[T]hese entities are not unobservable physical objects like atoms, electrons, etc., but rather [at least in the form of the theoretical language which I have chosen in [*MCTC*] [§VII] purely logico-mathematical entities, e.g., natural numbers, classes of such, classes of classes, etc." (1963, 963). The Ramsey-sentence says that "the observable events in the world are such that there are numbers, classes of such etc., which are correlated with the events in a prescribed way and which have among themselves certain relations; and this assertion is clearly a factual statement about the world" (ibid.). Surely though we cannot take literally this idea that mathematical entities are correlated with observable phenomena. What then does Carnap mean?

The distinctive feature of the Ramsey-sentence of a theory is that it preserves the structure (or form) of the original theory. So, it seems right

to interpret Carnap as suggesting the following: when one accepts $^{R}(TC)$ one is not committed to the existence of physical theoretical entities. All one is committed to is (a) the observable consequences of the original theory *TC*; (b) a certain logico-mathematical structure in which the observable phenomena are embedded; and (c) certain abstract existential claims to the effect that there are (non-empty classes of) entities which realise the structure. Since in $L_T$ to each physical concept there is an extensionally identical mathematical concept, the entities that realise the Ramsey-sentence, if true, can be taken to be sequences of mathematical entities.

Still, Carnap hasn't moved far enough from instrumentalism, or from what Feigl called "syntactical positivism".[7] For, in essence, theories are still taken to be nothing but mathematical structures in which observable phenomena are embedded. So, in his attempt to keep his distance from scientific realism, Carnap seems to betray his neutralism, once more. Expectedly, Carnap is unhappy with the idea of "syntactical positivism". "There is no 'positivism' here" he says in his letter to Feigl (4 August 1958). And he explains: "[T]he entities to which the variables in the Ramsey-sentence refer, are characterised not purely logically, but in a descriptive way; and this is the essential point. These entities are identical with mathematical entities only in the customary extensional way of speaking; see my example in square brackets on p.10.[8] In an intensional language (in my own thinking I use mostly one of this kind) there is an important difference between the intension 9 and the intension $n_p$. The former is $L$-determinate [ ... ], the latter is not. Thus, if by 'logical' or 'mathematical' we mean '$L$-determinate', then the entities to which the variables in the Ramsey-sentence refer, are not logical. I hope this will relieve your uneasiness".

Carnap's position can be clarified by looking at his notion of $L$-determinateness. This is introduced in his (1947[1956], 72–73) and aims to capture the difference between descriptive and logical designators. A designator is $L$-determinate in a language $L$ iff the semantical rules of $L$ alone, without additional factual knowledge, determine its extension. So, '9' is $L$-determinate, its extension being the class of all classes which are isomorphic to 9. But $n_p$: 'the cardinal number of planets' is $L$-indeterminate because finding its extension requires factual information. '$N_p = 9$' is a true identity statement. But it is synthetic, and hence contingently true. The extension of $n_p$ is determined by the way the world is, although, as it happens, it is identical with the extension of the $L$-determinate designator '9'. In other words, although it is true that '$n_p = 9$', $n_p$ is not *necessarily* equal to 9. Hence, there is a sense in which $n_p$ and 9 are different: they have

different intensions. But this sense cannot be captured in an extensional language such as $L_T$. In an extensional language, '$n_p = 9$' expresses an identity: '$n_p$' and '9' are just two expressions for the same class (of classes of) objects, a class which is designated on the one hand by a descriptive constant and on the other by a logical one.[9]

Insofar as we stick to an extensional language, it is tempting for an empiricist to take the second-order variables of the Ramsey-sentence to range over mathematical entities. These variables, extensionally understood, range over classes, classes of classes etc. What are these classes of? A natural thought is that they are classes of space-time points. But 'space-time point' is a theoretical term itself. Hence it has to be eliminated too (in favour of quadruples of numbers, in Carnap's case). But even if one resolved that the variables range over classes of space-time points etc., one would still miss something. Suppose we replaced the term 'mass' by an existentially quantified variable. From an extensional point of view, the Ramsey-sentence would assert the existence of a mathematical entity: a *function* from classes of space-time points to numbers. The extensional language $L_T$ simply does not have the resources to capture the difference between the theoretical concept *mass* and the relevant extensionally identical mathematical function.

Seen from an intensional perspective, however, the Ramsey-sentence approach looks different: although to each $T$-term there corresponds an extensionally identical mathematical designator, the *intensions* of the $T$-terms are physical concepts, not mathematical entities. So the intensions of $T$-terms are different from the intensions of logico-mathematical terms. Once we switch to an intensional language, the problem of the choice of the variables and of their range gets resolved. In Carnap's own method of extension and intension (cf. 1947[1956]), variables are allowed two interpretations, taking intensional values as well as extensional values (e.g., properties as well as classes, or individual concepts as well as individuals). Carnap's method allows the use of the same variables to quantify over theoretical entities (properties – the intensions of $T$-terms) as well as mathematical entities (the extensions of $T$-terms). So, the value-intensions of the variables will be theoretical entities, although their value-extensions may well be mathematical entities. We should not, however, fail to notice that this appeal to intensions breaks Carnap's desired neutrality once more. If an intensional language is admitted, how can he escape existential commitments to unobservable entities (properties)?

It's tempting to see Carnap's claim that the extensions of descriptive terms are mathematical entities as a mere artefact of his system without any independent motivation. Yet there is a deep reason why Carnap insists

on the extensional identity between theoretical and mathematical concepts. One of Carnap's major concerns is to show that his framework for the analysis of the language of theories can be adaptive enough to include new theoretical concepts that the physicist of the future might think up (cf. 1958, 80). Carnap's insistence on the extensional identity aims to address precisely this problem. When new physical concepts are introduced, the proposed framework can easily accommodate them because it can always provide the relevant extensionally identical mathematical functions. No matter what the features of a new physical magnitude may be, its logical type will be identical with a certain mathematical function, which can be expressed in $L_T$. So when new entities are introduced, there is no need to change radically the linguistic framework in which scientific theories are developed. Carnap's motivation is to introduce a framework rich enough to accommodate theories in the process of growth, and to provide means to compare scientific theories. For even when theories employ different theoretical concepts, they can still be compared from an extensional point of view, by finding the mathematical functions which correspond to these concepts and by examining whether these are extensionally identical, i.e., whether they have the same values for all points on which they are defined. In other words, Carnap's main motivation is the construction of a stable logico-linguistic environment for the development of scientific theories.[10]

In his Lecture Course on the Foundations of Physics, Carnap makes this point explicitly: "Thereby, I believe, we have entirely got rid of the problem how we can foresee the strange entities which physicists might introduce in the future. If you think of the theoretical entities as things of some kind which nobody has ever seen, like electrons or so, then you will think that we cannot foresee what strange kinds of things physicists will conjure up – we might not even be able to imagine them today. But if we assume that every physical theoretical term that will be introduced belongs to a certain type, then that type can be provided for. I think, even the system outlined above, containing all finite types, will presumably be sufficient for all concepts of physics for quite some time" (CA, 111-23-01) (cf. also 1966, 253).

## 6. EMPIRICISM AND REALISM-WITHOUT-THE-TEARS?

In light of what we've seen so far, it seems as though Carnap's neutralism is difficult to maintain: every attempt to restore an empiricist equidistance between realism and instrumentalism makes him fall towards one of these positions. Carnap has to take sides, doesn't he?

Well, there is still an option available to him: to say that the two positions are, after all, *not* in conflict. This much he says explicitly in his (1966, 256): "It is obvious that there is a difference between the meanings of the instrumentalist and the realist ways of speaking. My own view, which I shall not elaborate here is that the conflict between the two approaches [realism and instrumentalism] is essentially linguistic. It is a question of which way of speaking is to be preferred under given circumstances. To say that a theory is a reliable instrument – that is, that the predictions of observable events that it yields will be confirmed – is essentially the same as saying that the theory is true and that the theoretical, unobservable entities it speaks about exist. Thus, there is no incompatibility between the thesis of the instrumentalist and that of the realist. At least so long as the former avoids such negative assertions as, ' . . . but the theory does not consist of sentences which are either true or false, and the atoms, electrons and the like do not really exist' ".

Let me call the thesis expressed in this long quotation, the *strong compatibility thesis*. Such claim has justifiably raised many a philosopher's eyebrow (cf. Creath, 1985; Salmon 1994b). For if an instrumentalist were to give up the thesis that "the theory does not consist of sentences which are either true or false, and the atoms, electrons and the like do not really exist", then instrumentalism and realism, far from being genuine rivals, would end up being compatible. Would, however, Carnap want to establish this trivial reconciliation?

We need to go slowly here. Carnap struggles a lot with the formulation of his position and makes several corrections to the manuscript of chapter 26 of his *Philosophical Foundations of Physics* (CA, 111-23-04). His final word on the Ramsey-sentence approach is that "To ask whether there really *are* electrons is the same – from the Ramsey point of view – as asking whether quantum physics is true. The answer is that, to the extent that quantum physics has been confirmed by tests, it is justifiable to say that there are instances of certain kinds of events that, in the language of the theory, are called 'electrons' " (1966, 255). This is a view that many realists might be happy with because it asserts certain existential commitments. But Carnap takes this position not to be a realist one – in fact, he goes on to add: "this point of view is sometimes called the 'instrumentalist' view of theories".

If all there was to instrumentalism was captured by the 'Ramsey way', then Carnap would be right in saying that realism and instrumentalism were compatible. In the original manuscript of chapter 26, Carnap explains this compatibility very clearly: "Any object – from electron to galaxy – can be talked about in the Ramsey sentence, or in the traditional descriptive

[realist] language of science. The point I wish to emphasise is that, so far as the powers of a theory to explain and predict are concerned, the two language forms are equivalent" (CA, 111-23-04). Let me call this the *weak compatibility thesis*.

Oddly enough, Carnap decides to withdraw this passage and to replace it by the one asserting the (strong) compatibility between realism and instrumentalism in general. It is not surprising then that after he has asserted the strong compatibility thesis, he immediately weakens it by adding the qualification: realism and instrumentalism are compatible so long as instrumentalism "avoids such negative assertions as, ' ... but the theory does not consist of sentences which are either true or false, and the atoms, electrons and the like do not really exist' ". What Carnap has in mind is the 'Ramsey way'. What he wants to stress is that instrumentalism and realism are compatible insofar as the instrumentalist is not a typical instrumentalist, but rather an advocate of the 'Ramsey way'.

It is really unfortunate that Carnap crossed off the weak compatibility thesis. For it is this thesis which motivates his neutralism. For him, empiricists should be concerned with the power of the theory to explain and predict. And, Carnap seems to think, as far as *this* power is concerned, realism and the 'Ramsey way' fare the same. To be sure, realists typically assert more than the Ramsey-sentence proponents: realists use $T$-terms, they endow them with surplus meaning, and they take these terms to refer to unobservable entities. On the other hand, the Ramsey-sentence dispenses with $T$-terms. But it does not thereby reduce the 'excess' content of theories. Theories still imply existential commitments to things other than observables. The Ramsey-sentence may not assert that *electrons* exist, as opposed to whatever else might realise the Ramsey-sentence, if it is true. But it does assert that there are entities which realise the theory.

Besides, as Carnap (1958) observed, a scientific theory $TC$ is logically equivalent to the following conjunction: ${}^{R}(TC)$ & $({}^{R}(TC) \rightarrow TC)$. The conditional $({}^{R}(TC) \rightarrow TC)$ says that *if* there are entities that satisfy the Ramsey-sentence of the theory, then the $n$-tuple of $T$-terms of the theory should be taken to designate such entities. Carnap notes that this conditional has no factual content and takes it to be a meaning postulate.[11] On this reconstruction of scientific theories, the difference between a Ramsey-sentence proponent and a scientific realist is that the former sticks to ${}^{R}(TC)$, while the latter also accepts the meaning postulate $({}^{R}(TC) \rightarrow TC)$. Being a meaning postulate, this conditional has no extra empirical content over ${}^{R}(TC)$. It appears then that in asserting the existence of, say, electrons, the realist takes no extra empirical risks over the proponent of the 'Ramsey way'. Nor can she, on empirical grounds, persuade the proponent of the

'Ramsey way' to accept the existence of, say, electrons. All she can hope for is to convince her to talk about the entities that realise $^{R}(TC)$ as electrons etc. The proponent of the Ramsey-sentence approach, on the other hand, could accept that if theories are true, then there are electrons etc. In doing so, Carnap suggests, she would have to accept a meaning postulate, but she wouldn't go beyond the limits of empirical enquiry.

So, Carnap's empiricism appears able to remain neutral. Within the limits of empirical adjudication, scientific realism and the 'Ramsey way' are deemed equivalent. What is, however, important to stress is that the 'Ramsey way' should *not* be equated with an instrumentalist understanding of theories. Precisely because a typical instrumentalist would deny that theoretical entities exist, while $^{R}(TC)$ does not: it just offers an extensional treatment of theoretical discourse. All this means that Carnap's neutrality needs some qualification. His liberalised empiricism is not neutral in the debate between realism and instrumentalism. It's neutral vis-à-vis a realist or a Ramsey-sentence understanding of scientific theories.[12]

No wonder then Carnap's original strong compatibility thesis is eventually withdrawn, too, when the paperback edition of the *Philosophical Foundations of Physics* appears in 1974. Salmon (1994b) has documented that this change was brought about by Maxwell's insistence that the Ramsey-sentence approach should not be equated with instrumentalism. In fact, as we shall see in the next section, Maxwell thought that the 'Ramsey way' is best understood as structural realism. Commenting on Carnap's use of the Ramsey-sentence, Maxwell wrote to Carnap: "I disagree that thinking theoretical entities 'in the Ramsey way' should be associated with instrumentalism" (Maxwell to Carnap, 24 June 1966, CA, 027-33-29). Interestingly enough, Carnap wrote back in 9 December 1967 saying the following: "You are quite right in the one critical remark you make, that the Ramsey way should not be associated with instrumentalism. In an earlier version of the manuscript I had distinguished three instead of two views on the question of the reality of entities, by splitting off instrumentalism into two forms, a negativistic one and a neutral one which I identified with the Ramsey way. Then a reader of the manuscript pointed out that the distinctions were not in agreement with the customary terminology; in particular that the term 'instrumentalism' is always used in the negativistic sense. Then I made a radical change, distinguishing only two points of view. This I did in great haste and so I mixed things up. For a future edition of the book I have decided on a reformulation which you see on the enclosed sheet" (CA, 027-33-28).

## 7. STRUCTURAL REALISM

Is Carnap's final position sustainable? *Prima facie*, it seems that Carnap has managed to effect a compromise between his liberalised empiricism and some form of realism. For, Carnap thinks, all we need to do in order to achieve this reconciliation is adopt a *meaning postulate* ($\exists u TC(u, o) \rightarrow TC(t, o)$) for an $n$-tuple of $T$-terms and an m-tuple of already interpreted $O$-terms, which says: *if* the world is so constructed that there are classes of entities which satisfy $^{R}(TC)$, then the $T$-terms are to be understood in such a way that they designate these classes. By advocating a Ramsey-sentence approach to scientific theories, Carnap goes beyond strict empiricism, since the Ramsey-sentence approach entails a commitment to entities which realise the Ramsey-sentence. But this is not a fully realist position either, since asserting *what* these entities are is no longer a substantive assertion, but instead it reduces to adopting a meaning postulate.

However, Carnap's attempted reconciliation is too quick and doesn't work. In order to explain this clearly we need to make a small digression into a similar philosophical position which was developed by Bertrand Russell and demolished by M.H.A. Newman (cf. Demopoulos and Friedman, 1985). So, the reader's patience is begged at this stage.

In his *The Analysis of Matter* (1927), Russell suggested that when it comes to the knowledge of the unobservable world, only its structure, i.e., the totality of its formal, logico-mathematical, properties, can be known. All first-order properties of the unobservable entities – what Russell called "qualities" – are inherently unknown. What's so special about the logico-mathematical structure of the world, Russell thought, was that it could be legitimately *inferred* from the structure of the observable world. So, Russell's structuralism appears to be an attempt to reconcile empiricism and realism. His position is empiricist enough because it does not go beyond whatever can be known on the basis of experience, or be inferred from it. But it's also realist, because it posits more than the observable phenomena. Russell admits the existence of an unobservable world, and, on top of that, he also asserts that its structure can be known. Having clearly dissociated the Ramsey-sentence approach from instrumentalism, (and as we saw in the last section, having shown to Carnap that this dissociation is imperative), Grover Maxwell suggested that the Russellian position can be seen as a form of realism. This kind of realism, he thought, can be fully captured by the Ramsey-sentence approach to scientific theories. Given that the Ramsey-sentence of the theory preserves the structure of the original theory, Maxwell suggests that the 'Ramsey way' is best understood as "structural realism". As such, it suggests that (i) scientific

theories issue in existential commitments to unobservable entities and (ii) all non-observational knowledge of unobservables is *structural knowledge*, i.e., knowledge not of their first-order (or intrinsic) properties, but rather of their higher-order (or structural) properties (cf. 1970; 1970a). In Maxwell's own words: "our knowledge of the theoretical is limited to its purely structural characteristics and ( . . . ) we are ignorant concerning its intrinsic nature" (1970a, 188).

What Maxwell did not see was that there is a damaging objection to the Russellian programme. It was pointed out by the mathematician M. H. A. Newman in his (1928). Newman's argument is, in essence, the following. In order to structure a particular domain $D$, one must first specify a definite relation (or set of relations). Can the structuralist just say of this relation that it exists and that the structure it generates on a domain $D$ is known (say, it is $W$), without saying *what exactly* this relation is? If he did, he would assert something trivial and uninformative. For, the structuralist claim that there is a relation which generates a certain structure $W$ on a domain $D$ offers no empirical information about the domain other than its cardinal number. The reason for this is that a domain $D$ can be so arranged (or 'carved up') that it possess *any* structure whatever compatible with its cardinality, and hence the structure imposed by the relation whose existence the structuralist asserts. If all one stated was that "*(t)here is* a relation $R$ such that the structure of the external world with reference to $R$ is $W$", and if the domain of discourse had enough individuals, then one would never fail to find such a structure $W$ (cf. Newman 1928, 144). Newman summed up the point as follows: "Hence the doctrine that *only* structure is known involves the doctrine that *nothing* can be known that is not logically deducible from the mere fact of existence, except ('theoretically') the number of constituting objects" (ibid.).[13]

How does this objection apply to Carnap's attempt to effect a reconciliation between realism and empiricism? As noted in the beginning of this section, Carnap's master thought was that the realism-empiricism question revolves around the adoption of a meaning postulate $(\exists u TC(u, o) \rightarrow TC(t, o))$ for an $n$-tuple of $T$-terms and an $m$-tuple of already interpreted $O$-terms, which says: *if* the world is so constructed that there are classes of entities which satisfy ${}^{R}(TC)$, then the $T$-terms are to be understood in such a way that they designate these classes. What realists, however, should stress is that it is an open question whether the antecedent of the conditional $(\exists u TC(u, o) \rightarrow TC(t, o))$ (i.e., 'that the world is so constructed that there are classes of entities which satisfy ${}^{R}(TC)$') is true or false. Consequently, they should stress that it should be an open issue whether or not the $T$-terms designate anything: the $n$-tuple of $T$-terms of the theory

does designate something if the Ramsey-sentence is true, but it does *not* designate anything if the Ramsey-sentence is false, i.e., if the world is not so constructed that there are classes of entities which satisfy *TC*. By stressing all this, realists do justice to our pre-philosophical intuition that theories make substantive claims about the world which are true, if at all, empirically and not *a priori*. This is precisely where Carnap's approach goes wrong. It makes the truth of the substantive claims made by scientific theories *a priori* knowable. For, unless certain restrictions are imposed on the range of the second-order variables of the Ramsey-sentence, and given that *the Ramsey-sentence is empirically adequate*, it is *always true* (i.e., it cannot possibly be false) that there are classes, and classes of classes, etc. which satisfy the Ramsey-sentence of the theory. It follows directly from the Newman challenge to Russell's position that if the domain of the theory is merely seen as a set of objects, which possesses no natural structure, then this domain can be so 'carved up' that the Ramsey-sentence is true of it, and never false of it. Hence, provided that the Ramsey-sentence is empirically adequate, the antecedent of the conditional $(\exists u TC(u, o) \rightarrow TC(t, o))$, viz., the claim that 'the world is so constructed that there are classes of entities which satisfy *TC*', is always true. No empirical investigation is required for finding out whether it is true. [14]

Notice now that given that the Ramsey-sentence $\exists u TC(u, o)$ is always true, and that $(\exists u TC(u, o) \rightarrow TC(t, o))$, one can infer that the theory $TC(t, o)$ is also true. What this means is that provided that the Ramsey-sentence is empirically adequate, we can rely just on *a priori* reasoning in order to discover what entities realise the theory, i.e., what unobservable entities populate the world. No empirical investigation is necessary. In the end, if no constraints are imposed on the range of the variables of the Ramsey-sentence, it is *a trivial and a priori true assertion* that there are electrons, etc. And this is clearly absurd. For, to say the least, it appears obvious that the theory $TC(t, o)$ *could* be false, even though it is empirically adequate. It's false just in case the unobservable entities it posits are not part of the furniture of the world. Hence, if the theory can be false, it's a substantive claim that it is true, if it is true. And no substantive claim can be arrived at by *a priori* reasoning. Carnap's argument makes the truth of a theory $TC(t, o)$ trivial, since it allows of no possibility of the theory $TC(t, o)$ being false, given that its Ramsey-sentence is empirically adequate.

It is easy to see that the problem raised by Newman is particularly acute for Carnap's own understanding of Ramsey-sentence. As we have seen, Carnap suggests that all the theory needs to assert is that there are mathematical entities which stand in a certain relation to the

observable phenomena, where this relation is expressed by a purely logico-mathematical predicate *TC*. Since, however, the domain of discourse of $L_T$ is the power set of $D^0$, (i.e., of the set of natural numbers), it's going to contain any and every relation on $D^0$ (understood extensionally). Hence, it can possess any and every structure whatever, and in particular the desired structure imposed by *TC*, whatever that may be. No empirical investigation is necessary for finding out whether $\exists u TC(u, o)$ is true. The very fact that the domain of discourse is rich enough guarantees that $\exists u TC(u, o)$ is true, i.e., that there are classes (and classes of classes etc.) of numbers which stand in relation *TC* to $o$, provided of course that $\exists u TC(u, o)$ is consistent with the observable facts. Carnap seems to be willing to bite the bullet and impose no restrictions on the range of the variables of the Ramsey-sentence. But, as we have just seen, he thereby makes all theoretical assertions made by an empirically adequate scientific theory *a priori* true.

Newman's challenge questions directly the coherence of a Ramsey-sentence approach to theories. For the challenge remains even *after* the intended interpretation of the domain of discourse has been fixed (e.g., numbers, or space-time points). Put simply, the problem is to specify the *nature* of the relation we refer to when we say that there are entities that stand in *TC* to $o$. Even if we specify the domain of discourse, and even if the relational structure is such that it gets connected with some observable properties and entities, the problem still is that the relation *TC* is not yet determined: too many different but isomorphic theoretical structures can be defined on the same domain of individuals such that they account for exactly the same observations, that is, such that they 'surface' in the same way. Given that all these structures are structurally identical (isomorphic), the structural realist – restricted as he is by his view that only the structure of a relation can be known – has no means at his disposal to choose between them. Newman sees this point very clearly. The problem is precisely to distinguish "between the systems of relations that hold among the members of a given aggregate. ( . . . ) In the present case we should have to compare the importance of relations of which nothing is known save their incidence (the same for all of them ) in a certain aggregate" (1928, 147). And he adds: "For this comparison [between structurally identical relations] there is no possible criterion, so that 'importance' would have to be reckoned among the prime unanalyzable qualities of the constituents of the world, which is, I think, absurd" (ibid.). So, if one wants to specify *which* relation is the appropriate one to choose, then one would have to go *beyond* structure and talk about what these relations *are*.

So, the proponents of a Ramsey-sentence approach to theories (who, following Maxwell, may be called "structural realists") are caught in a dilemma. Either they should choose to avoid addressing the issue of which structures are specified by theories and their Ramsey-sentences, thereby making the claim that theories are true empty and *a priori* true. Or they should have to appeal to *non-structural considerations* in order to say which structures are important, thereby undermining the distinction between knowledge of structure and knowledge of nature upon which they base their epistemology and their understanding of theories. To put the point in a different way, either structural realists do not restrict the range of the variables of the Ramsey-sentence or they do. If they don't, then the claim that theories are true, given that they are empirically adequate, becomes an a priori and trivial truth. If, on the other hand, they do opt for a restriction of the range of the variables so that, for instance, they range over natural classes (kinds, properties), then in order for them to distinguish between natural and non-natural classes, they have to admit that some non-structural knowledge is possible, viz., that some classes are natural, while others are not. And the only way to do that is to rely on interpreted scientific theories and to take them as their guides as to which properties and relations are the natural constituents of the world.

This is precisely where scientific realists differ from structural realists: that they appeal to the language of theories and its intended interpretation in order to deem important those relations and structures which the physical theories – with their inegalitarianism, as Lewis (1984) puts it – deem important. Those relations and structures are important which characterise (or aim to capture) the pre-existing natural kind-structure of the world. If the world has already had a certain natural kind-structure, then it is no longer a trivial exercise to construct theories that match this structure. It is no longer guaranteed that the theories will be true of the world (cf. Lewis, 1984). Nor is it guaranteed that their Ramsey-sentences will be true. For, given what we've seen, the only condition under which a Ramsey-sentence which is empirically adequate can be false is if the second-order variables are suitably constrained to range over natural classes and relations between them: the Ramsey-sentence is false *just in case* the classes whose existence it asserts are not natural, i.e., just in case the Ramsey-sentence does not capture the natural-kind structure of the world. And clearly, if the Ramsey-sentence $\exists u TC(u, o)$ of the theory $TC(t, o)$ can be false, then so can the theory, since the theory implies its Ramsey-sentence. The claim that world has a definite natural-kind structure (i.e., that some classes (properties) are natural while others are not) is not a purely structural claim. It is a

substantive claim about how the world is, its truth being presupposed for any meaningful defence of structuralism.[15]

To me, all this suggests that if a Ramsey-style structural realism is unstable, then so much the better for scientific realism. But, in its full details, this is a different story. Carnap's best case for his own empiricism was put forward in his endorsement of the Ramsey-sentence approach. This seemed to safeguard his own neutralism. But at a price: collapsing his empiricism to some form of structural realism. If the latter is not to become a trivial thesis, nor to collapse to scientific realism, then at least a story needs to be told as to how it can survive the Newman challenge.

## NOTES

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1 Here I use the description of $L_T$ that Carnap gives in his (1958), which is the same, only more detailed, as the one offered in *MCTC*.

2 The reader might look at Quine's (1966; 1985) and Maxwell's (1962) criticisms of this distinction.

3 Carnap (1946[1949], 345) says: "I am using here the customary realistic language as it is used in everyday life and in science; this use does not imply acceptance of realism as a metaphysical thesis but only what Feigl calls 'empirical realism' ". Cf. also his "Comments on Feigl's 'Philosophy of Science' " Jan. 18, 1955, CA, (090-62-03).

4 Let's give a brief account of their provenance. Carnap's reply to Hempel's piece in the Schilpp volume was finished in 1958 but did not appear until 1963. Then, in the academic year 1958–59, Carnap gave a lecture course on the Foundations of Physics in which, in lecture XIV delivered in 6 January 1959, he presented his new views. This lecture course was the basis of his later book "The Philosophical Foundations of Physics" which appeared in 1966, although the chapter on the Ramsey-sentence was written in 1961 and finalised in 1964. In December 1959, there was his address "Theoretical Concepts in Science" in

a symposium in Santa Barbara, CA, on 'Carnap's Views on Theoretical Concepts in Science'. (This lecture is now scheduled to appear, with an introduction by me, in *Studies in History of Philosophy of Science*. cf. Psillos (1999)). Then, in May 1960, Carnap finished his piece "On the Use of Hilbert's $\epsilon$-operator in Scientific Theories", which appeared in 1961 in a festschrift to A. A. Fraenkel.

[5] Take any sentences $S$ which does not contain any theoretical terms. It can be proved that it follows from the Ramsey-sentence iff it follows from the original theory. The proof is as follows: $\vdash \exists u\Phi(u, o) \rightarrow S \leftrightarrow\vdash \neg S \rightarrow \neg\exists\Phi(u, o) \leftrightarrow\vdash \neg S \rightarrow \forall u\neg\Phi(u, o) \leftrightarrow\vdash \forall u(\neg S \rightarrow \neg\Phi(u, o)) \leftrightarrow\vdash \forall u\Phi(u, o) \rightarrow S) \leftrightarrow\vdash \Phi(t, o) \rightarrow S$.

[6] It might be thought that my interpretation of Ramsey's insight commits him to a kind of realism about theoretical entities. But, as a perceptive anonymous reader reminded me, it is hard to think that Ramsey wanted to defend a realist view. The reader noted that Ramsey's conception of scientific theories is closer to phenomenalism, as can be evinced by his only recently published "Notes on Theories" (cf. Ramsey, 1991). I do not want to commit myself to a realist reading of Ramsey-sentences by Ramsey himself. For I think, the quick and somewhat cryptic remarks that Ramsey made should be seen as an attempt to cut through the whole issue of how theoretical entities can be possibly referred to, since they cannot be known by acquaintance. But I also find a quick identification of Ramsey's views with phenomenalism unwarranted. The whole (subtle) issue is discussed in my "Ramsey on Scientific Theories" which was presented at a conference on Ramsey, at King's College London in November 1997.

[7] As Feigl characterised it in his brilliant (1950), syntactical positivism is a form of instrumentalism: "the view that the entities which figure in the laws of theoretical science are *nothing but* useful formal constructs; the theories themselves being 'nothing but' mathematical models. The upshot then is still: the theoretical constructs are auxiliary devices, they are *façons de parler*, abbreviatory schemes for the description of the complex relationships between observables" (1950, 46–47).

[8] Carnap refers to the example $n_p$: 'the cardinal number of planets'.

[9] Carnap's approach is explained in detail in his lecture course on the Foundations of Physics 1958–59, (Lecture XIV, CA, 111-23-01).

[10] I think that Carnap aimed to solve what was later on called Kuhnian 'incommensurability'. But the details of this thought cannot be developed here.

[11] This is in essence how Carnap solves the problem of analyticity for a theoretical language. For more on this cf. my (1999).

[12] This is as close as one can get to Creath's characterisation of Carnap as "irenic realist" (1985, 18). I am not sure though that the terminology is apt. It seems essential not to lose the neutralist element of Carnap's empiricism. At any rate, Creath's perspective is different. He presses the point that Carnap must, after all, be more of a scientific realist than he seems willing to accept. For if observational discourse is ontologically committing, and if there is no sharp dichotomy between observational discourse and theoretical one, then – by continuity – theoretical discourse must be ontologically committing, too. The issue I have tried to raise is that Carnap has been willing to accept all this and yet unwilling to accept that his empiricism commits him to physical unobservable entities.

[13] As Demopoulos and Friedman (1985) have documented, Russell conceded this point to Newman. In a letter to Newman, Russell observes: "You make it entirely obvious that my statements to the effect that nothing is known about the physical world except its structure are either trivial or false, and I am somewhat ashamed at not having noticed the point myself". Russell goes on to say that he had implicitly assumed that the important relation is

that of spatio-temporal continuity, or causality, between the world of percepts and the world of unperceived objects. Be that as it may, it should be clear that this is just an admission of defeat. Either there are things about the unobservable world which can be known although they are not purely structural claims, or no substantive knowledge of the unobservable is ever possible.

[14] A Ramsey-sentence is empirically adequate when all of its observational consequences are true. If the Ramsey-sentence is not empirically adequate, then the whole issue I am discussing cannot be raised. But Carnap's attempted compromise between empiricism and realism can work only if empiricists could somehow stop at the level of an empirically adequate Ramsey-sentence and then relegate the issue over its truth to the issue of adopting a meaning postulate. In any case, what I am saying should not be confused with the claim that the Ramsey-sentence has to be (or necessarily is) empirically adequate. This is an open empirical question.

[15] Lewis's (1970) way to introduce theoretical terms is very close to Carnap's (1961). But Carnap and Lewis disagree over the uniqueness-of-realisation thesis: Lewis asserts it, but Carnap does *not* want to commit himself to it. However, talking of 'unique realisation' is a bit ambiguous. It might be taken to exclude *multiple realisations* in the sense of excluding different domains of objects realising the same structure. But, requiring uniqueness of this sort would do nothing to avoid the Newman problem. So, I take it that, requiring uniqueness should amount to requiring that there is a unique relation-in-extension *TC* which structures the specific domain such that the entities of this domain stand in *TC* to *o*. Requiring *this* kind of uniqueness is nothing other than requiring that the domain is already carved up in natural kinds, and that there are natural relations holding among them. This issue is also discussed in Horwich's (1982). Horwich, however, suggests that the solution rests on a conventional decision as to how we formulate our beliefs.

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