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ON EXTENDING "EMPIRICISM, SEMANTICS, AND ONTOLOGY" TO THE REALISM/INSTRUMENTALISM CONTROVERSY*

> If, in some cataclysm, all of scientific knowledge were to be destroyed, and only one sentence passed on to the next generations of creatures, what statement would contain the most information in the fewest words? I believe it is the *atomic hypothesis*…that *all things are made of atoms—little particles that move around in perpetual motion, attracting each other when they are a little distance apart, but repelling upon being squeezed into one another.*
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> —Richard Feynman[1]

The concept of a linguistic framework and the distinction between internal and external questions are the central ideas of Rudolf Carnap's "Empiricism, Semantics, and Ontology."[2] It is not uncommon to encounter the suggestion that reflection on the theoretical and experimental investigations which led to the acceptance of the atomic hypothesis undermines Carnap's distinction between these two types of question and the utility of his notion of a linguistic framework. I believe this is a mistake. There is a natural development of the distinction and the notion of framework choice with which it is paired that is perfectly capable of accommodating this case. I show

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[1] Richard Feynman, *Lectures on Physics, Vol. 1* (New York: Addison-Wesley, 1963), p. 1-2.

[2] Rudolf Carnap, "Empiricism, Semantics, and Ontology," *Revue Internationale de Philosophie*, IV, 2 (1950): 20–40. Revised and reprinted in Carnap, *Meaning and Necessity: A Study in Semantics and Modal Logic*, enl. ed. (Chicago: University Press, 1956), pp. 205–21. I will use the acronym *ESO* to refer to this article. All page numbers refer to its 1956 reprinting.

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this by bringing out a subtlety that arises in the extension of the conceptual apparatus of *ESO* to the realism/instrumentalism controversy. When this subtlety is taken into account, the question contested by the nineteenth- and early twentieth-century opponents and proponents of the atomic hypothesis, and successfully addressed by Einstein and Perrin, is readily seen to be internal. Moreover, this formulation of the distinction and the controversy are both independent of Carnap's views on cognitive significance and factual content. I conclude with a presentation and discussion of two formulations of the realism/instrumentalism controversy that are based on Carnap's explication of the factual content of a theory in terms of the notion of its Ramsey sentence.

I. THE NATURE OF THE PROBLEM

Carnap's primary objective in *ESO* was to clarify the basis for employing a language with expressions for abstract entities. He sought to show that an empiricist should regard the use of such a language as entirely uncontroversial, since it is neither favorable to Platonism nor unfavorable to nominalism when these doctrines are understood in their classical senses as doctrines about the reality or otherwise of abstract entities. The source of the difficulty with the classical doctrines is that they present themselves as theories that inform us about reality rather than as proposals involving the utility of a language form. In so doing they misconstrue the "external" questions they address as comparable in significance to "internal" existence questions. Carnap singles out for special criticism a position he attributes to Paul Bernays,[3] one according to which the use of real-number variables for the representation of spatio-temporal coordinates is enough to make a committed Platonist of someone who uses the language of physics as a system of communication "even if he is a strict empiricist who rejects Platonic metaphysics" (*ESO*, 215).

ESO thus seeks to clarify the controversy surrounding the legitimacy of a language which employs expressions for abstract entities with this distinction between two types of question. In broad outline, Carnap's basic idea was that internal questions raise genuine existence questions which require a "theoretical investigation." By contrast, external questions raise issues that are addressed by the practical decision to accept a linguistic framework.[4] A key point of Carnap's distinction is

[3] Paul Bernays, "Sur le platonisme dans les mathématiques," *L'Enseignement Mathématique*, XXXIV (1935): 52–69.

[4] Not all cases involving framework choice are plausibly regarded as purely matters of practical decision. Something more than practical necessity may be involved when

that it is characteristic of the answers to genuine internal questions that they are capable of settling "nontrivial" questions of existence, such as questions pertaining to the existence of elementary particles with various properties in the case of physics, and the existence of numbers and functions satisfying certain conditions in the case of mathematics. This notion of nontriviality is an informal one: it does not exclude the possibility that a nontrivial answer to an existence question is sometimes an analytic truth. In this case, the answer's nontriviality consists in its having a psychologically informative logical derivation from analytic truths. But when an external question is mistakenly posed as if it were an internal existence question, the answer is characteristically trivial and analytic, even when it purports to address a question of fact rather than a question of logic or mathematics. Notice therefore that Carnap's distinction between internal and external questions cannot be straightforwardly identified with the analytic/synthetic distinction.[5]

Carnap gives as a mark of externality the difference between questions that involve the existence of particular elements (or particular classes of elements in the domain of entities over which our individual variables range) from questions about the existence of the entire system of individuals, or some other logical category of entity. He goes on to suggest that any question about a whole system of entities is likely to signal an external question, while a question about the existence of a particular element of the domain is typically an internal one. However,

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a mathematical theory is selected for the formulation of a physical theory. For example, Carnap tells us:

> the external questions of the reality of physical space and physical time are pseudo-questions. A questions like "Are there (really) space-time points?" is ambiguous. It may be meant as an internal question; then the affirmative answer is, of course, analytic and trivial. Or it may be meant in the external sense: "Shall we introduce such and such forms into our language?"; in this case it is not a theoretical but a practical question, a matter of decision rather than assertion, and hence the proposed formulation would be misleading. Or finally, it may be meant in the following sense: "Are our experiences such that the use of the linguistic forms in question will be expedient and fruitful?" This is a theoretical question of a factual, empirical nature. But it concerns a matter of degree; therefore a formulation in the form "real or not?" would be inadequate. (*ESO*, 213)

Although of great importance, cases of this last sort raise issues related to the application of the concept of framework choice and the distinction between internal and external questions that fall outside the scope of this paper. For a preliminary discussion of such cases see Michael Friedman, *Dynamics of Reason* (Stanford: CSLI, 2001).

[5] This is emphasized by Carnap when he remarks that once "new forms are introduced into the language, it is possible to formulate with their help internal questions and possible answers to them. A question of this kind may be either empirical or logical; accordingly a true answer is either factually true or analytic" (*ESO*, 214).

this is at best a rough guide, one that can be undermined if the domain is assumed to be many-sorted and the sorts are classified in a way that is unfavorable to the intuition Carnap is trying to capture.[6]

Our methods for resolving internal questions follow an intricate and evolving system of rules of proof and evidence, and the answers to these questions consist in the theories and existence claims we come to accept on the basis of such methods. It is a mark—but only a mark—of external questions that these methods, which I will refer to as our "ordinary methods" of proof and evidence, are incapable of resolving them. Because external questions are resistant to our ordinary methods, Carnap holds that they must be answered by a practical decision. But intractability to ordinary methods is insufficient to distinguish external questions from questions which are "merely intractable." For example, there are open questions in number theory that may turn out to be intractable to ordinary methods, but they are unlikely candidates for external questions if our responses to them have little in common with the selection of a linguistic framework. These considerations suggest that the internal/external distinction and the notion of a linguistic framework are interdependent concepts, so that our understanding of them must be achieved in tandem rather than sequentially.

Although intractability to ordinary methods and the property of pertaining to the existence of a domain of quantification are only marks of an external question, they may nevertheless be instructive when considered in conjunction with particular cases. Such a development of the internal/external distinction will be successful to the extent that the classification it determines is capable of providing an illuminating reconstruction of the product of our collective theoretical investigations. However, before considering an example that is particularly instructive in connection with Carnap's distinction, it will be worthwhile briefly to describe a change of linguistic framework that does *not* rest on the distinction between these two types of question. This case of framework change figures prominently in *Logical Syntax of Language*,[7] a work that precedes *ESO* and the formulation of the internal/external distinction. The change of framework it involves is not associated with one or another metaphysical view; nor does it involve the transformation of a philosophical problem into one of choice of language.

By contrast with common examples of what might prove to be intractable problems of number theory, Gödel's discovery of sentences

[6] See W. V. O. Quine, "On Carnap's Views on Ontology," *Philosophical Studies*, II, 1 (January 1951): 65–72.

[7] Carnap, *Logical Syntax of Language*, trans. Amethe Smeaton (London: Routledge and Kegan Paul, 1937); hereafter, abbreviated *LSL*.

undecidable in first-order arithmetic raises a general question about the characterization of arithmetical truth, one that in *LSL* Carnap proposed to address by a change of linguistic framework. The evident candidate for such a characterization is a definition in terms of deduction from a recursive set of arithmetical sentences in accordance with finitary rules of inference. But Gödel's first incompleteness theorem shows that there is no finitary characterization of the class of arithmetical truths: every such characterization must leave some sentences neither arithmetically true nor arithmetically false, and thus, in the terminology of Carnap's *LSL*, neither analytic nor analytically false or contradictory. Carnap argued that for anyone who holds that such sentences are not synthetic, Gödel's discovery shows that the definition of analyticity must be emended. This is a purely technical problem, demanding a purely technical solution. Carnap's solution is based on a fundamental theorem of *LSL*, namely 14.3 (*LSL*, 40). This theorem justifies the adequacy of Carnap's proposed new definition of 'analytic' for the arithmetical fragment of *LSL*'s Language I. (Henceforth, I will take it to be understood that my remarks about *LSL*'s Language I are restricted to its arithmetical fragment. This fragment is a form of primitive recursive arithmetic.) The theorem's content and Carnap's definition may be expressed simply (if somewhat anachronistically) given a small number of preliminary notions.

Suppose we are given a first-order language L with equality, where L is the arithmetical language customarily adopted to express the first-order theory of the standard model of arithmetic. In L it is possible to form a *numeral name* for each natural number n using just the nonlogical symbols for zero and successor. A *numerical instance* of a universally quantified sentence $\forall x\varphi(x)$ is the sentence which results from the substitution of a numeral name for the free variable x in $\varphi(x)$. ω is the rule of proof which allows us to pass from all the numerical instances of a universally quantified sentence to the universal sentence itself; *Carnap's theorem* is the proposition:

> If T is a theory in L strong enough to decide all atomic formulas, then $T + \omega$ is complete with respect to all formulas of L.[8]

Carnap's partial solution to the "crisis" caused by Gödel's discovery of essential incompleteness proceeds by dropping the finitariness constraint

[8] For the history of ω (the "ω-rule") see Solomon Feferman, "Introductory Note to 'Review of Hilbert, *Die Grundlegung der elementaren Zahlenlehre*'," in Feferman et al., eds., *Kurt Gödel: Collected Works, Volume 1* (New York: Oxford, 1986), pp. 208–13. My exposition of Carnap's theorem was suggested by Daniel Isaacson, "Some Considerations on Arithmetical Truth and the ω-rule," in Michael Detlefsen, ed., *Proof, Logic and Formalization* (New York: Routledge, 1992), pp. 94–138.

on rules of proof and proposing a relation of deduction that includes the infinitary rule of proof ω. He then argues (in effect) that the analytic sentences of Language I are given by the deductive closure of a theory which satisfies the conditions of his theorem, where the deductive closure is taken relative to this expanded and *nonfinitary* system of rules of proof. Since primitive recursive arithmetic is one such theory, every sentence of Language I is analytic or contradictory in the sense of Carnap's definitions. Without some such infinitary notion, arithmetical truth would be left indeterminate. *LSL*'s introduction of the ω-rule remedies this indeterminateness, and from the perspective of both *LSL* and *ESO*, its introduction constitutes a change of linguistic framework, a change whose utility consists in its provision of a determinate concept of arithmetical truth. Indeed, Carnap's proposal is essentially equivalent to the definition of arithmetical truth in terms of truth in the standard model of arithmetic. And because of the extensional equivalence between Carnap's *analytic in the arithmetical fragment of Language I* and *arithmetically true* in the sense of Tarski, Carnap's definition of analyticity for Language I is often compared with the application of Tarski's definition of truth to the case of arithmetical truth.

As we will see, the idea Carnap pursues in *ESO* is to transform classical philosophical controversies into choices among proposals to adopt one or another language form. This is *not* the point of *LSL*'s discussion of the bearing of Gödel's theorem on the nature of our knowledge of arithmetic. A necessary condition for a solution to this latter question of the sort that Carnap would find acceptable is that we should be in possession of a notion of *analytic in Language I* which partitions the class of arithmetical sentences into two classes: those that are analytic and those that are analytically false. Carnap's definition in terms of ω does this, and this shows that an important *condition of adequacy* for an account of the kind he favors can be met.

LSL's proposed solution to the characterization of arithmetical truth involves what in the terminology of *ESO* would count as a change of linguistic framework. However, it is important to recognize that the transition to a framework that admits a nonfinitary rule of proof neither *solves* nor *dissolves* the philosophical problem of explaining the a priori character of arithmetical knowledge, but serves only to show that Carnap's preferred solution, according to which mathematical knowledge consists in a priori knowledge of analytic truths, has not been automatically ruled out by Gödel's discovery of essential incompleteness. It should also be noted, if only in passing, that it would be a mistake to represent Carnap as following a method of "truth by stipulation," since he does not simply stipulate the conclusion he requires, but gives an informative analysis of arithmetical truth in terms of the ω-rule and then proceeds

to demonstrate its adequacy for his purposes. That the theorem which establishes this is not mathematically difficult is quite irrelevant to its interest or to the correctness of Carnap's deployment of it.

There are important points of difference between the notion of framework change that can be extracted from *LSL* and the use to which this notion later came to be put in *ESO*, when it was combined with the distinction between internal and external questions. Although both works are concerned with changes of framework, Carnap's goal in *ESO* is to show how the notion of a linguistic framework can be used to *transform* a traditional metaphysical problem into a problem of an altogether different character. Carnap's proposal is that opposed metaphysical positions should not be regarded as differing views about reality, but as expressions of different preferences for the choice of a linguistic framework. According to *ESO*, this is true of the dispute between realists and phenomenalists and, as we noted earlier, of the dispute between Platonists (to whom Carnap sometimes refers as realists in the medieval sense) and nominalists. Questions about reality are susceptible to resolution by ordinary methods. Questions that are advanced as questions about reality, but that are not amenable to such methods, are without "cognitive significance" and should be transformed into questions about the choice of a language form. By contrast, *LSL*'s extension of the linguistic framework to facilitate the definition of analyticity does not transform any philosophical question into one of framework choice. And although it bears on the epistemological question of the nature of arithmetical knowledge, the change in linguistic framework which the extension effects leaves that question pretty much open.[9]

ESO does not list the realism/instrumentalism controversy as an example of an external question, but it would be surprising if, at the time of this paper, Carnap did not regard the question the controversy raises as an external one. When in the book based on his seminar on the philosophy of science Carnap touches on the realism/instrumentalism debate, he suggests an approach to the controversy that is reminiscent of what in *ESO* he argued in connection with the debate between Platonists and nominalists:

> the question should not be discussed in the form: "Are theoretical entities real?" but rather in the form: "Shall we prefer a language of physics (and of science in general) that contains theoretical terms, or a language

[9] A pre-echo of *ESO*'s approach to metaphysical questions occurs in *LSL*'s discussion of "pseudo-object" sentences. For a recent discussion of *LSL* on pseudo-object sentences as "quasi-syntactic" and its relation to *ESO*'s subsequent conception of metaphysical questions as external, see André W. Carus, *Carnap and Twentieth-Century Thought: Explication as Enlightenment* (New York: Cambridge, 2007), pp. 256ff.

> without such terms?" From this point of view the question becomes one of preference and practical decision.[10]

A footnote to this passage directs the reader to *ESO* where, we are told,

> [the view that] greater clarity often results if discussions of whether certain entities are real are replaced by discussions of preference of language forms….is defended in detail.

But the book has little further to say on the subject.

In the balance of this paper, I will give an account of the application of the distinction between internal and external questions to the realism/instrumentalism controversy that, although in many ways faithful to *ESO*, is not the simple extension that Carnap proposes. Nor will my proposal appeal to the notion of cognitive significance or to a tendentious characterization of metaphysics; to the extent that a development free of these ideas proves possible, Carnap's views about linguistic frameworks and the distinction between his two types of question will have been shown to be independent of notions that are generally regarded as problematic.

I will begin with a reconstructive proposal for understanding the application of the distinction between internal and external questions to the nineteenth- and early twentieth-century debate over the atomic hypothesis and the question of the reality of atoms. The discussion of the example of the atomic hypothesis will guide the formulation of my proposal for extending the conceptual apparatus of *ESO* to the realism/instrumentalism controversy. I will then turn to Penelope Maddy's important and influential recent criticism of Carnap on the status of the atomic hypothesis in order to show how, on the extension I propose, the issues Maddy raises can be successfully addressed. I will conclude by explaining how Carnap's Ramsey-sentence reconstruction of the language of science bears on the nature of the realism/instrumentalism controversy. We will see that there is more than one way to adapt this reconstruction to the task of extending the internal/external distinction to the controversy between realists and instrumentalists.

II. THE REALISM/INSTRUMENTALISM CONTROVERSY AND THE ATOMIC HYPOTHESIS

Even though *ESO* does not discuss the example of the atomic hypothesis and the question of the reality of atoms, one reason why the hypothesis is of special interest is not hard to see: if Carnap's proposals regarding framework choice and abstract entities could be shown to apply *mutatis*

[10] Carnap, *An Introduction to the Philosophy of Science*, ed. Martin Gardner, 2nd ed. (New York: Dover Books, 1995), p. 256.

mutandis to a case which, like the case of the reality of atoms, is very implausibly represented as a choice of linguistic framework, then this would be a reason to reject his analysis even for the case of abstract entities, for which it was originally intended. The link between the atomic hypothesis and framework choice we will need to explore in order to address this possibility is the realism/instrumentalism controversy and its bearing on the historical debate surrounding the question of atomic reality.

It is natural to view the controversy that separates realists and instrumentalists as one that concerns opposing views of theories which postulate unobservable entities. From this perspective, the question posed by the atomic hypothesis is just a special case of a more general question about the existence of unobservables. It would then seem to follow that if realists and instrumentalists are divided on an external question, proponents and opponents of the atomic hypothesis must also be divided on an external question. But then, according to Carnap's understanding of external questions, the atomic hypothesis raises a question that is covertly about the practical utility of a language form. Hence, to accept the atomic hypothesis and the reality of atoms is to make the practical decision to adopt a particular linguistic framework. But reducing the question of the existence of atoms to a question that can be settled by the adoption of a form of language certainly has the ring of a reductio of Carnap's distinction. Is there an extension of the conceptual apparatus of *ESO* to the realism/instrumentalism controversy and the atomic hypothesis that avoids this consequence?

Suppose we try to develop a more abstract approach to the question which divides realists and instrumentalists and view it as raising a meta-theoretical question about the nature of theories in general. The notion that the issue is a meta-theoretical one is arguably implicit in the assertion that the question driving the controversy is whether theories express truths or are merely instruments that enable us to negotiate among phenomena. The proposal that the atomic hypothesis is just an instrument for prediction would then seem to reduce to the claim that atoms are useful fictions. But it is far from obvious that the question whether atoms are fictions is not naturally addressed by refining ordinary methods so that they may be brought to bear more decisively on the question of the reality of atoms. In this case the question the atomic hypothesis poses might be better classified as internal rather than external. But then our meta-theoretical interpretation of the realism/instrumentalism controversy does not clearly succeed in representing the question of realism as an external one.

There thus appear to be two natural interpretations of the realism/instrumentalism controversy, neither of which fits comfortably with the ideas of *ESO*: on the interpretation which takes it to raise a question

about unobservable entities, the question of the reality of atoms is transformed into a linguistic question. And on the interpretation which takes it to raise a question about the "purely instrumental" character of theories, the question which separates realists and instrumentalists might well be amenable to a theoretical investigation using ordinary methods and should be classified as internal. A major goal of *ESO* is to show that what often appears as a single question may split into two or more radically different questions. It is therefore consistent with the position set forth in *ESO* to view the existence of atoms as indicative of a general and possibly external question about the nature of theories *and* as an internal question regarding the probable outcome of the application of our ordinary methods of theoretical investigation. Is there a way of developing the internal/external distinction that does not reduce the atomic hypothesis to a linguistic proposal and at the same time preserves the external character of the question of realism versus instrumentalism?

What made the atomic hypothesis importantly different from other theories—and what makes the nineteenth-century controversy surrounding it especially significant for the extension of *ESO*—is the fact that it was widely perceived that the hypothesis might prove intractable to our ordinary methods of theoretical and experimental analysis, with the consequence that there might never be a sufficient basis for deciding it one way rather than another. Given the restrictions to which ordinary methods appeared at one time to be subject, it would have been neither absurd nor unreasonable to doubt whether the question of the existence of atoms could ever be satisfactorily resolved. And indeed, many participants in the nineteenth-century debate over the question of atomism voiced just such a view. The issues were complex and far subtler than whether or not the confirmation of the atomic hypothesis was held to too high a standard by its "verificationist" opponents. The difficulties urged against the hypothesis were sensitive to particular formulations of it, and in the most interesting cases centered on the arbitrariness with which early formulations of the hypothesis allowed key theoretical parameters to be set. Able atomists had able energeticist critics. This left the status of the hypothesis in doubt: in the terminology of the nineteenth-century debate, it left in doubt whether atoms are real or are merely useful fictions. Operating under the not unreasonable but, as it happens, false supposition that the question is intractable, one might well have concluded that the hypothesis is a "metaphysical" one, hence one that poses an external question.[11]

[11] In this connection it is interesting to recall Poincaré's essay "Hypotheses in Physics," where a distinction is drawn between hypotheses which are "natural and necessary," such

Einstein and Perrin provided the definitive account of how to use the phenomenon of Brownian motion to refine our ordinary methods to a point where they could reasonably be held to establish the reality of atoms. In so doing they vindicated the insights of Léon Gouy and others regarding the relevance of Brownian motion and the kinetic theory of gasses to the verification of a physical-chemical hypothesis about the constitution of matter.[12] The Einstein-Perrin analysis achieved two broad successes: (i) it led to new determinations of Avogadro's number, the molecular diameter, and numerous other parameters by exploiting independent sources of evidence and new experimental techniques. But in addition, (ii) Perrin's confirmation of Einstein's quantitative analysis showed that Brownian motion refutes the strict (nonstatistical) validity of Carnot's principle, and hence also that of the Second Law of Thermodynamics. The strict validity of Carnot's principle was not only a central pillar of the energeticist argument in favor of its alternative to atomism, it was a central pillar of its critical assessment of atomism.[13] As Michael Gardner has observed, it is the

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as the suppositions "that the influence of very distant bodies is quite negligible, that small movements obey a linear law, and that [an] effect is a continuous function of its cause," and those that should be qualified as "neutral." Poincaré argued that the atomic hypothesis falls into the second category: "In most questions the analyst assumes, at the beginning of his calculations, either that matter is continuous, or on the contrary, that it is formed of atoms. He might have made the opposite assumption without changing his results. He would only have had more trouble to obtain them—that is all." Regarding an analyst whose calculations assume a neutral hypothesis like the atomic hypothesis, Poincaré continues, "If…experiment confirms [such an analyst's] conclusions, will he suppose that he has proved, for example, the real existence of atoms?" The clear suggestion of "Hypotheses in Physics" is that no respectable analyst would draw such a conclusion because he would recognize that the hypothesis is merely a convenient aid to calculation. (All quotations are from the reprinting of "Hypotheses in Physics" in Henri Poincaré, *The Foundations of Science*, trans. George Bruce Halsted (Lancaster, PA: The Science Press, 1913), p. 135. For the French original see "Les Relations entre la Physique Expérimentale et la Physique Mathématique," *Revue Générale des Sciences Pures et Appliquées*, XI (1900): 1163–75, at p. 1166.) The idea that the atomic hypothesis is at best a convenient aid to calculation was by no means Poincaré's final view on the subject. See especially his "Les Conceptions Nouvelles de la Matiere," *Foi et Vie*, XV (1912): 185–91. A translation of this essay by Melanie Frappier and Jeffrey Bub, together with an introduction by me, Frappier, and Bub which explains the essay's significance in Poincaré's evolving views about atomism is forthcoming in *Studies in History and Philosophy of Modern Physics*.

[12] The historical development is described in detail in Mary Jo Nye, *Molecular Reality: A Perspective on the Scientific Work of Jean Perrin* (New York: Elsevier, 1972). Nye remarks that Léon Gouy was the only major French physicist to have dealt with the problem of Brownian motion before Perrin. Gouy was prescient, but he did not have the benefit of the quantitative analysis of Einstein and others.

[13] Maxwell's Demon hypothesis made it clear that the molecular hypothesis must allow for the possibility that the Second Law holds only statistically. What was striking about Perrin's confirmation of Einstein's quantitative analysis of molecular motion

combination of these two successes that explains why the Einstein-Perrin analysis of Brownian motion was a development of previous work with such decisive significance for resolving the question of atomic reality.[14] This is therefore a case where what appeared to some to be a question that could only be resolved by a practical decision was shown to be entirely amenable to an innovative extension of ordinary methods. In short, Einstein and Perrin undermined whatever justification there may have been for regarding the question of the atomic hypothesis as *external because intractable*.

It is clearly desirable that an extension of *ESO* which represents the realism/instrumentalism controversy as one involving an external question should be compatible with the idea that the Einstein-Perrin analysis demonstrated the existence of atoms. What such an extension might nevertheless call into question is whether the successful deployment of ordinary methods in support of the hypothesis can be parlayed into a general argument in favor of realism over instrumentalism. The intuition that it cannot is based on the idea that when realism and instrumentalism are understood as meta-theoretical claims about the interpretation of theories, it is generally assumed that both realists and instrumentalists agree on what theories the evidence favors and on the decisiveness with which it favors one theory over another. Understood as an external question about realist and instrumentalist interpretations of theories, the question of the existence of atoms is not one ordinary methods address. But granting this does not preclude the possibility that there is a perfectly good *internal* question about the reality of atoms that *is* addressed by such methods.

I have placed special emphasis on the idea that the *point* of Carnap's distinction is to clarify situations in which what appears as a single

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was its demonstration, via the phenomenon of Brownian motion, of the violation of Carnot's principle at the molecular dimensional scale. The topic is discussed by Perrin:

> [Carnot's] principle asserts…that in a medium in thermal equilibrium no contrivance can exist capable of transforming the calorific energy of the medium into work….[t]hat is to say, [into] doing work without taking anything in exchange and without external compensation. [Such] *perpetual motion of the second kind* is held to be impossible. Now we have only to follow, in water in thermal equilibrium, a particle denser than water, to notice that at certain instants it rises spontaneously, thus transforming a part of the heat of the medium into work. If we were no bigger than bacteria, we should be able at such moments to fix the dust particle at the level reached in this way, without going to the trouble of lifting it and to build a house…without having to pay for the raising of the materials.

See Jean Perrin, *Atoms*, trans. D. L. Hammock (New York: Van Nostrand, 1916), pp. 86–87.

[14] Michael Gardner, "Realism and Instrumentalism in 19th-Century Atomism," *Philosophy of Science*, XLVI, 1 (March 1979): 1–34.

question about a hypothesis splits into two or more very different questions, each having a methodology appropriate to its resolution. In keeping with our discussion of the atomic hypothesis, it is natural to distinguish those questions that are amenable to ordinary methods of theoretical investigation from those that are not. This brings us to the subtlety that arises in the application of the internal/external distinction to the realism/instrumentalism question that I noted earlier: among the questions that are not amenable to ordinary methods, we should distinguish between questions for which ordinary methods fail to *stabilize* on a particular hypothesis—as at one time seemed would be the case for the atomic hypothesis—and questions that *fall altogether outside the purview* of such methods. Both are possible cases of external questions. But it is only the case where a question is judged to be external because it is believed that ordinary methods will never stabilize on a verdict that involves a speculative guess about the future of science. The view that atoms should be regarded as useful fictions was based upon just such a speculative guess. As we saw, such guesses can be mistaken, with the consequence that the views they are taken to support—such as the view that atoms are merely useful fictions—become groundless.

The situation is different with questions which fall outside the scope of what ordinary methods can deliver. That there should be external questions in this sense is clearly essential to the point of Carnap's distinction. But the elaboration and defense of the distinction should be compatible with a variety of approaches to establishing that there are such questions. One way to establish this is to appeal to the idea that the metaphysical question which separates realists and instrumentalists is one that concerns the language within which our understanding of claims regarding the truth of theories is expressed. On this way of framing the debate, the instrumentalist maintains that truth should be identified with warranted assertability, while the realist denies any such identification. Theoretical and experimental investigations based on ordinary methods, however decisive, are irrelevant to whether the evidence garnered by such methods can compel us one way or the other on which language form to adopt.[15]

[15] Carnap has a remark on the nominalism/realism controversy that comes very close to this formulation of what constitutes a question as external:

> I cannot think of any possible evidence that would be regarded as relevant by both philosophers, and therefore, if actually found, would decide the controversy or at least make one of the opposite theses more probable than the other.…Therefore I feel compelled to regard the external question as a pseudo-question… (*ESO*, 219)

On my formulation it is the clarification of the *externality* of the question that the decisiveness of ordinary methods is capable of illuminating; I should also emphasize that on my formulation, there are different ways in which ordinary methods can fail to decide a thesis. (Thanks to Thomas Uebel for bringing this passage to my attention.)

Such an account of the external question which separates realism from instrumentalism is reminiscent of the view of realism and its critics that for a long time has been defended by Michael Dummett.[16] Rather surprisingly, it represents a possible extension of the apparatus of *ESO* to the realism/instrumentalism controversy that is faithful to many of Carnap's basic ideas. However this "Dummettian" extension does not rest on a notion of cognitive significance; nor does it rest on a pejorative characterization of metaphysical questions as meaningless. Nevertheless, Dummett's proposal that the decision about which notion of truth to adopt should turn on our choice of logic is certainly consonant with Carnap's view that our choice of logic and our answers to external questions are alike matters of practical decision concerning framework choice. Where Carnap and Dummett differ is over Dummett's suggestion that both logic and metaphysics can be derived from an underlying theory of meaning, and the correlative idea that this observation is capable of mitigating the conventionality that for Carnap attaches to answers to external questions and our choice of logic.

We are therefore in a position to conclude that it is at least consistent with the framework of *ESO* that (i) the reality of atoms raises an internal question, but (ii) this recognition is compatible with an understanding of the realism/instrumentalism controversy according to which the question separating realists and instrumentalists cannot be decided by ordinary methods. At the same time, (iii) it can happen that the internal or external nature of an existence question, such as the one raised by the atomic hypothesis, depends on the capacity of ordinary methods to stabilize on a verdict for the hypothesis in question.

III. A RECENT CRITICISM OF *ESO*

In *Second Philosophy: A Naturalistic Method*, Penelope Maddy remarks on the wide range of things that according to *ESO* are candidates for linguistic frameworks; not only is there a linguistic framework for abstract entities, but there is also one for atoms:

> there is a linguistic framework for talking about observable things and events in space and time, which Carnap calls 'the thing language'.... There are...linguistic frameworks for numbers, including variations with weaker or stronger logics; linguistic frameworks for unobservable entities like atoms, with evidential rules spelling out what observations would count as evidence for and against; mathematics-heavy linguistic

[16] See, for example, Michael Dummett, *The Logical Basis of Metaphysics: The William James Lectures, 1976* (Cambridge: Harvard, 1991).

> frameworks for relativity theory, for quantum mechanics, and so on.… Questions of existence, of logic, of evidence and truth, he insists, can only be asked within a framework, as it is the framework alone that gives them cognitive significance.[17]

It is important to recognize that the suggestion that Carnap requires a special linguistic framework for atoms, or an "atom framework," in order to raise the issues about the constitution of matter that the atomic hypothesis addresses is an extrapolation from *ESO*. Indeed, as we have emphasized, *ESO* does not even *mention* the philosophical controversy that is most closely associated with the atomic hypothesis. And when, in *ESO*, Carnap does consider an extension of the thing language, it is not an extension to the atom framework he considers, but an extension to a framework that includes space-time points. This question is in turn immediately reduced to one involving the mathematical resources of the linguistic framework and whether spatio-temporal coordinates should be given by integers or by rational or real numbers.[18]

Maddy's initial objection, which is directed at the claim that the reality of atoms is to be resolved by the conventional adoption of a linguistic framework, is therefore an objection to an extrapolation from Carnap's remarks, rather than to an explicit thesis of *ESO*:

> [L]et's suppose we've adopted a linguistic framework for simple scientific observation and generalization—perhaps an elaboration of the thing language—and we're wondering whether or not to embrace a new range of entities, say atoms. As our current language has no terms for such things, no predicate 'is an atom', no evidential rules with which to settle questions of their existence or nature, Carnap holds that this is not a question that can be asked or answered internally, that we must step outside our linguistic framework and address it pragmatically, as a conventional decision about whether or not to adopt a new linguistic framework.…
>
> [Now t]he meticulous and decisive work of Jean Perrin on Brownian motion came as a welcome surprise. In circumstances like these, where the new evidential rules are such elusive and hard-won scientific achievements, [one] is unlikely to agree with Carnap that their adoption is a

[17] Penelope Maddy, *Second Philosophy: A Naturalistic Method* (New York: Oxford, 2008), pp. 68–69.

[18] "The step from the system of things (which does not contain space-time points but only extended objects with spatial and temporal relations between them) to the physical coordinate system is again a matter of decision. Our choice of certain features, although itself not theoretical, is suggested by theoretical knowledge, either logical or factual. For example, the choice of real numbers rather than rational numbers or integers as coordinates is not much influenced by the facts of experience but mainly due to considerations of mathematical simplicity" (*ESO*, 212). I am grateful to Michael Friedman for calling my attention to this passage.

> purely pragmatic matter, a conventional choice of one language over another. [Rather] the development of the Einstein/Perrin evidence was of a piece with [our] standard methods of inquiry.…[Even if] the empirical study of human language use might justify some notion of purely linguistic truth, [it is doubtful] that a distinction so grounded would put the relevance of Einstein/Perrin's work to the existence of atoms on the linguistic side of the ledger.[19]

According to Maddy, the distinction between internal and external questions is so poorly drawn, and the concept of a linguistic framework so unconstrained, that there is no basis for objecting to a classification of the question of the existence of atoms as wholly one of framework choice. But then the notions of external question and linguistic framework yield a clearly incorrect interpretation of the significance of the work of Einstein and Perrin. And since their work constitutes one of the most significant chapters in the history of the atomic theory, this is sufficient to justify rejecting the method of rational reconstruction that is based on these notions.

I hope it is clear that such an objection overlooks the multifaceted role ordinary methods play in the distinction between internal and external questions, and I hope it is also clear that such an objection imputes too simple a picture to the part played by framework choice in settling existence questions. *ESO* is *not* compelled to represent the atomic hypothesis as raising a question of framework choice in Maddy's sense, let alone as *merely* raising a question of framework choice in this sense. And while it is, of course, true that on Carnap's view the question regarding the existence of atoms which was addressed by Einstein and Perrin demands a "linguistic framework" for its formulation and eventual resolution, this is not a thesis anyone should dispute. The sense in which the atomic hypothesis may be held to require a linguistic framework need amount to nothing more than the demand for a language within which questions about the constitution of matter can be meaningfully posed. Such a demand neither implies nor is intended to imply that the question addressed by Einstein and Perrin is about language choice. The conceptual resources of such a framework can be considerably less than the totality of possible theories with which we might speculate about the constitution of matter, and insofar as the framework must allow for a variety of possible answers, there must also be a sense in which it is more than the conceptual resources of any particular theory. As we have seen, it is entirely compatible with the conceptual apparatus of *ESO* for there to be an altogether different explanation of why the question of the reality of atoms may sometimes

[19] Maddy, *op. cit.*, pp. 71–73.

take the form of an external question. According to our proposal, the practical decision involves a choice between frameworks which agree in admitting the possibility of quantification over atoms but differ in their notions of truth: in one truth is stronger than warranted assertion, while in another it coincides with warranted assertion.

Maddy also considers the possibility that the question of the reality of atoms is a special case of the external question that separates realists from instrumentalists. In a discussion that is explicitly directed at *LSL* and Carnap's "Principle of Tolerance," but which is also intended to apply to *ESO*'s emphasis on the pragmatic character of the choice of a linguistic framework, Maddy writes:

> [T]he 'scientific realist', who believes that atoms exist, reconstructs scientific theorizing along the lines of the atom language, once again with evidential rules strong enough to allow us to justify our belief in what we cannot directly observe. For his counterpart, the 'instrumentalist', the projected evidential rules are weaker, and we can never know such things. Carnap's point is that what seems a serious philosophical question, the locus of heated debate—can we know…that atoms exist?—actually hinges on no more than a conventional choice of rational reconstruction.[20]

But there is a fundamental difficulty with this way of subsuming the question of the existence of atoms under the external question that is contested by realists and instrumentalists. By representing Carnap's position as one that makes the existence of atoms relative to the choice of a *realist* or an *instrumentalist* rational reconstruction of the atomic theory and its evidential base, Maddy effectively forecloses the possibility that for Carnap the question of the reality of atoms splits into an internal question that is amenable to ordinary methods and an external question that is not amenable to such methods. Let me conclude this section with a summary of what I take the discussion so far to have established.

Maddy's discussion is directed at showing that both Carnap's distinction and its point are unclear. But on our proposed extension of *ESO* to the realism/instrumentalism controversy, there should be

[20] *Ibid.*, p. 79. This last remark is clarified in a footnote:

> To put [it] another way: Carnap holds that the actual language the 'realist' and the '[instrumentalist]' are speaking is hopelessly imprecise, amorphous; that it only makes sense to speak of evidence in the context of a rational reconstruction; that their shared language can be reconstructed in various ways, some conducive to realism and some to [instrumentalism]; that there's no fact of the matter at stake in the choice between these possible reconstructions, only a pragmatic choice.

Maddy's discussion focuses on realism, instrumentalism, and skepticism; I have made it uniformly about realism and instrumentalism, and have omitted any reference to skepticism. My insertion of '[it]' in the first line of Maddy's footnote corrects an obvious typo.

little for Maddy's "Second Philosopher" to find fault with. The clarity of the distinction between internal and external questions and its extension to the realism/instrumentalism controversy rests only on the clarity of the notion of ordinary methods of proof and evidence, and this is a notion whose clarity the Second Philosopher should be willing to concede. As for the *point* of Carnap's distinction, it aims to clarify the scope of our ordinary methods and the character of those questions, if any, which transcend them. But the clarification of the scope of our ordinary methods is a goal that the Second Philosopher also shares; at most, she is likely to disagree with Carnap over whether there are questions that transcend our ordinary methods and that therefore demand a practical decision regarding the choice of a language form. The nature of truth is plausibly such a question. But on this understanding of Carnap's distinction, the question addressed by Einstein and Perrin is no more one of language choice than it is for the Second Philosopher. And insofar as the question of the reality of atoms is not decided by a choice of a linguistic framework, as on Maddy's account of Carnap it must be, her implicit conception of how the apparatus of *ESO* extends to the realism/instrumentalism controversy should be resisted.

IV. CARNAP AND THE REALISM/INSTRUMENTALISM CONTROVERSY

Is there a place subsequent to *ESO* where Carnap discusses the question of the reality of atoms from the perspective of the controversy between realists and instrumentalists? And if so, how do his views compare with the view of the hypothesis and the controversy presented here?

In his response to Hempel in his "Replies and Systematic Expositions,"[21] Carnap considers a question that is in all relevant respects the same as the question of the reality of atoms, and what he says in connection with it bears comparison with our reconstruction of the distinction between internal and external questions and its relevance to the atomic hypothesis. After explaining how the Ramsey sentence of a theory succeeds in eliminating theoretical *terms*, Hempel observed that the Ramsey sentence does not eliminate reference to theoretical *entities*.[22] Hence, in the case of at least some theories, any

[21] Carnap, "Replies and Systematic Expositions," in Paul Arthur Schilpp, ed., *The Philosophy of Rudolf Carnap* (La Salle, IL: Open Court, 1963), pp. 859–1013.

[22] Carl G. Hempel, "The Theoretician's Dilemma: A Study in the Logic of Theory Construction," in Herbert Feigl, Michael Scriven, and Grover Maxwell, eds., *Minnesota Studies in the Philosophy of Science, Vol. II* (Minneapolis: Minnesota UP, 1958), pp. 37–98. The notion of the Ramsey sentence of a finitely axiomatized theory assumes that the theory's nonlogical vocabulary has been partitioned into observation and theoretical terms; the Ramsey sentence is then formed by existentially generalizing away the

domain over which the Ramsey sentence of the theory is interpreted must be an extension of the domain of observable entities. Isn't it therefore the case that a proposed reconstruction in terms of Ramsey sentences favors realism? And isn't this in tension with Carnap's suggestion which we quoted earlier, that the question of realism reduces to the linguistic question of whether the reconstruction of the language of physics should include theoretical terms?[23]

Carnap's reply depends on the assumption that a theory and its Ramsey sentence have the same *factual content*, where this means that a theory's Ramsey sentence can replace the original theory in any argument to a conclusion formulated in the theory's observation vocabulary. Any such argument requires for its formulation only the observation vocabulary of the original theory together with the theory's logical and mathematical apparatus. But the terms belonging to the observation vocabulary are just terms of the thing language whose criteria of application have been refined and more precisely regimented. Carnap concedes that since both realists and instrumentalists accept the thing language—with its vocabulary regimented and its logical and mathematical resources suitably enriched—they must both also accept any extension of the domain of observable entities that is demanded by the Ramsey-sentence reconstruction of the theory. As we just saw, this is precisely what Hempel suggests is too strong a conclusion to be acceptable to an instrumentalist.

Carnap argues, against Hempel, that the Ramsey sentence does not favor realism on the ground that while it

> does indeed refer to theoretical entities by the use of abstract variables.… it should be noted that these entities are…purely logico-mathematical entities, e.g., natural numbers, classes of such, classes of classes, etc.

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theoretical terms. The philosophically contentious thesis that Ramsey-sentence reconstructions share with the logical-empiricist conception of theories is the assumption that our understanding of the theoretical vocabulary is importantly incomplete and problematic in a way that our understanding of the observation vocabulary is not. A Ramsey-sentence reconstruction takes this incompleteness of the theoretical vocabulary to justify the claim that the Ramsey sentence captures the theory's "factual" content.

[23] Carnap, *An Introduction to the Philosophy of Science*, p. 256. The 1966 date of the first-edition publication of *An Introduction to the Philosophy of Science*, under the title *Philosophical Foundations of Physics: An Introduction to the Philosophy of Science*, does not accurately reflect the temporal development of Carnap's views. The Ramsey-sentence reconstruction was presented as early as 1959 in Carnap's address to the American Philosophical Association in Santa Barbara, and Carnap was in correspondence with Hempel and Feigl on these matters much earlier than this. See the historical notes to the publication of the transcription of Carnap's address in Stathis Psillos, "Rudolf Carnap's *Theoretical Concepts in Science*," *Studies in History and Philosophy of Science*, XXXI, 1 (2000): 151–72.

> Nevertheless, [the Ramsey sentence] is obviously a factual sentence. It 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.[24]

One possible interpretation of these remarks—which constitute the core of Carnap's reply to Hempel—is that the Ramsey sentence of a theory admits an interpretation, in the sense of a specification of a domain for its bound variables, that should be acceptable to an instrumentalist; at the same time, it does not preclude a realist interpretation. On this understanding of the controversy, realism and instrumentalism should not be viewed as alternative rational reconstructions of the language of science, but as alternative interpretations of its *preferred reconstruction* in terms of the notion of a Ramsey sentence. However different realism and instrumentalism may appear as interpretations of a theory's Ramsey sentence, they concur in their representation of the theory's factual content. And since questions of factual content exhaust the internal questions a theory is capable of raising, realism and instrumentalism can differ at most on an external question.

Such an interpretation of Carnap's reply to Hempel suggests the following picture of his conception of theories which, like the atomic hypothesis, involve unobservable entities: assuming realists and instrumentalists both accept the Ramsey-sentence reconstruction of any such theory, they must agree on the theory's factual content. The Ramsey-sentence reconstruction makes a concession to realism by countenancing extensions of the domain of observable entities; at the same time, it concedes to instrumentalism the alternative of understanding any such extension entirely in terms of the number- and set-theoretical apparatus of the representational framework within which the theory is formulated. That both interpretations are equally legitimate is justified by Carnap's explication of factual content. As for the external question on which they differ, the formulation that naturally suggests itself is that the question is whether, as the realist holds, some theories, like the atomic hypothesis, describe a reality that transcends our observation in a fundamental way, or whether, as the instrumentalist maintains, such theories merely present us with an elaborate mathematical apparatus with which to successfully anticipate the phenomena we observe. The decision between these alternatives is a practical one because both realists and instrumentalists accept the Ramsey sentence as a correct reconstruction of factual content. As with our Ramsey

[24] Carnap, "Replies and Systematic Expositions," p. 963.

sentence-independent account of the external question that separates realism from instrumentalism, the decision is expressed by a choice of framework, namely, by a choice of *interpretational* framework for evaluating the truth of the Ramsey sentence of the theory. Finally, by its elimination of theoretical vocabulary, the Ramsey sentence confirms the intuition that internal theoretical questions regarding unobservables can be posed in the thing language, a language which is acceptable to both realists and instrumentalists.

For anyone who accepts Carnap's Ramsey-sentence reconstruction of the language of science, this should appear a defensible account of the realism/instrumentalism controversy as an external question. However, it is not entirely clear that it is the defense Carnap is proposing, and several considerations can be raised against the claim that it accurately represents his view. First, there is the passage in which Carnap locates the difference between realism and instrumentalism in the acceptance or rejection of the use of theoretical vocabulary.[25] By contrast, the proposed account has both realists and instrumentalists concurring in their acceptance of a reconstruction that declines the use of theoretical vocabulary. Secondly, and more importantly, in his response to Hempel Carnap does not suggest that the variables of the Ramsey sentence *may* be differently interpreted, but declares that their *correct* interpretation is in terms of "purely logico-mathematical" entities.[26] Thirdly, Carnap argues that physicists may, if they so choose,

> evade the question about [the existence of electrons] by stating that there are certain observable events, in bubble chambers and so on, that can be described by certain mathematical functions, within the framework of a certain theoretical system.…[T]o the extent that [the theoretical system] has been confirmed by tests, it is justifiable to say that there are instances of certain kinds of events that, in the theory, are called "electrons."[27]

Thus, for Carnap the question of realism concerns the convenience that may or may not attach to the use of theoretical vocabulary, much as in *ESO* the question of Platonism is transformed into one that rests on the convenience afforded by a language which contains expressions for abstract entities.

These considerations suggest that even if our proposed account of the realism/instrumentalism controversy in terms of Carnap's

[25] Carnap, *An Introduction to the Philosophy of Science*, p. 256.
[26] I am indebted to Anil Gupta for emphasizing this point to me.
[27] *Ibid.*, pp. 254–55.

Ramsey-sentence reconstruction of theories may be defensible, it is very likely not his account. To be sure, it shares with Carnap's proposal the idea that the question separating realists and instrumentalists is not factual, but it construes the question of framework choice differently: on our application of his Ramsey-sentence reconstruction, realists and instrumentalists evaluate the truth of the Ramsey sentence relative to different interpretational frameworks. For Carnap, realists and instrumentalists are divided over whether to use theoretical vocabulary, with realists endorsing its use and instrumentalists refraining from its use. Carnap's view of the controversy is entirely continuous with his approach in *ESO* to the Platonism/nominalism controversy: Carnap seeks to legitimize the use of theoretical vocabulary without incurring a commitment to realist metaphysics, just as, in the case of Platonism, he sought to show that the use of a language with expressions for abstract objects should not be taken to involve a commitment to Platonic metaphysics.

But in light of our discussion of the atomic hypothesis, Carnap's deployment of his Ramsey-sentence reconstruction should strike us as unsatisfactory: it portrays the question of the reality of unobservables as metaphysical, hence one that should be transformed into a question of preference for theoretical vocabulary. But then it is difficult to see how the question of the reality of atoms—which are just a special case of unobservables—should not also be regarded as a question of linguistic preference. This is to relinquish at the level of the realism/instrumentalism debate everything we struggled to sustain in connection with the significance of the work of Einstein and Perrin, since it leaves Carnap open to the charge that the question the atomic hypothesis raises can be settled by a choice of language.

Our proposal for applying Carnap's Ramsey-sentence reconstruction to the realism/instrumentalism controversy—our Ramsey sentence-*dependent* proposal—begins from the premise that for both realists and instrumentalists the Ramsey sentence of a theory yields its correct reconstruction. If this is granted, then the question which separates realists and instrumentalists must be an external one. This question is represented as involving the preferred interpretational framework for evaluating the truth of the Ramsey sentence. This proposal leaves intact the intuition that the decision whether to accept the atomic hypothesis is not a practical one about the desirability of using theoretical vocabulary. The contrast between it and Carnap's deployment of the Ramsey sentence reflects a difference in conception regarding the problems of abstract and theoretical entities. Pre-analytically, there is an underlying presumption in favor of the theoretical entities of physics; this is evident from the

epigraph of this paper. Such a presumption is far less clear in the case of abstract objects and purely mathematical theories. For an adherent of Carnap's Ramsey-sentence reconstruction, the extension of *ESO* that I am proposing respects this difference. It does so not by arguing against Platonism in mathematics, but by presenting an account of the realism/instrumentalism controversy that, unlike Carnap's, does not elide the difference between the issues realism poses in the case of physics with the questions it raises in the case of mathematics.

By contrast, our Ramsey sentence-*independent* proposal for extending the distinction between internal and external questions to the realism/instrumentalism controversy does not rest on Carnap's explication of factual content, but appeals only to our ordinary methods of proof and evidence and the idea that when our methods stabilize in the evaluation of alternative hypotheses, the issue that separates realists from instrumentalists concerns the nature of truth and its relation to warranted assertion. As we have just seen, even Carnap's account of the debate—in terms of his explication of the factual content of a theory by its Ramsey sentence—is strengthened when it is seen to turn on issues involving truth, in the present case, on different conceptions of how to understand the truth of the Ramsey sentence. I would like to conclude by emphasizing once again that the core ideas of *ESO*—the distinction between internal and external questions and the notion of a linguistic framework—are independent not only of the notion of cognitive significance, but are also independent of the central tenets of Carnap's Ramsey-sentence reconstruction of the language of science. One of the most fundamental of these tenets concerns the nature of the epistemic primacy which is accorded the observation language. It is not my purpose here to assess this tenet.[28] I will only remark that it is a highly nontrivial assumption, and for anyone attracted to the ideas of *ESO,* it should be a welcome consequence that it is an assumption which their defense does not require.

WILLIAM DEMOPOULOS

The University of Western Ontario

[28] See William Demopoulos, *Logicism and Its Philosophical Legacy* (New York: Cambridge, 2012) for an extended discussion and assessment of this and other tenets of Carnap's Ramsey-sentence reconstruction.