

WISSENSCHAFTLICHE WELTAUFFASSUNG: DER WIENER KREIS

[The Scientific Conception of the World: The Vienna Circle] I

Dedicated to Moritz Schlick

PREFACE

At the beginning of 1929 Moritz Schlick received a very tempting call to Bonn. After some vacillation he decided to remain in Vienna. On this occasion, for the first time it became clear to him and us that there is such a thing as the 'Vienna Circle' of the scientific conception of the world, which goes on developing this mode of thought in a collaborative effort. This circle has no rigid organization; it consists of people of an equal and basic scientific attitude; each individual endeavours to fit in, each puts common ties in the foreground, none wishes to disturb the links through idiosyncrasies. In many cases one can deputise for another, the work of one can be carried on by another.

The Vienna Circle aims at making contact with those similarly oriented and ,at influencing those who stand further off. Collaboration in the Ernst Mach Society is the expression of this endeavour; Schlick is the chairman of this society and several members of Schlick's circle belong to the committee.

On 15-16 September 1929, the Ernst Mach Society, with the Society for Empirical Philosophy (Berlin), will hold a conference in Prague, on the epistemology of the exact sciences, in conjunction with the conference of the German Physical Society and the German Association of Mathematicians which will take place there at the same time. Besides technical questions, questions of principle are to be discussed. It was decided that on the occasion of this conference the present pamphlet on the Vienna Circle of the scientific conception of the world was to be published. It is to be handed to Schlick in October 1929 when he returns from his visiting professorship at Stanford University, California, as token of gratitude and joy at his remaining in Vienna. The second part of the pamphlet contains a bibliography compiled in collaboration with those concerned. It is to give a survey of the area of problems in which those who belong to, or are near to, the Vienna Circle are working.

Vienna, August 1929

For the Ernst Mach Society

Hans Hahn, Otto Neurath, Rudolf Carnap

1. THE VIENNA CIRCLE OF THE SCIENTIFIC CONCEPTION OF THE WORLD

1.1. Historical Background

Many assert that metaphysical and theologising thought is again on the increase today, not only in life but also in science. Is this a general phenomenon or merely a change restricted to certain circles? The assertion itself is easily confirmed if one looks at the topics of university courses and at the titles of philosophic publications. But likewise the opposite spirit of enlightenment and *anti-metaphysical factual research* is growing stronger today, in that it is becoming conscious of its existence and task. In some circles the mode of thought grounded in experience and averse to speculation is stronger than ever, being strengthened precisely by the new opposition that has arisen.

In the research work of all branches of empirical science this *spirit of a scientific conception of the world* is alive. However only a very few leading thinkers give it systematic thought or advocate its principles, and but rarely are they in a position to assemble a circle of like-minded colleagues around them. We find anti-metaphysical endeavours especially in England, where the tradition of the great empiricists is still alive; the investigations of Russell and Whitehead on logic and the analysis of reality have won international significance. In the U.S.A. these endeavours take on the most varied forms; in a certain sense James belongs to this group too. The new Russia definitely is seeking for a scientific world conception, even if partly leaning on older materialistic currents. On the continent of Europe, a concentration of productive work in the direction of a scientific world conception is to be found especially in Berlin (Reichenbach, Petzoldt, Grelling, Dubislav and others) and in Vienna.

That Vienna was specially suitable ground for this development is historically understandable. In the second half of the nineteenth century, liberalism was long the dominant political current. Its world of ideas stems from the enlightenment, from empiricism, utilitarianism and the free trade movement of England. In Vienna's liberal movement, scholars of world renown occupied leading positions. Here an anti-metaphysical spirit was cultivated, for instance, by men like Theodor Gomperz who translated the works of J. S. Mill, Suess, Jodl and others.

Thanks to this spirit of enlightenment, Vienna has been leading in a scientifically oriented people's education. With the collaboration of Victor Adler and Friedrich Jodl, the society for popular education was founded and carried forth; 'popular university courses' and the 'people's college' were set up by the well-known historian Ludo Hartmann whose antimetaphysical attitude and materialist conception of history expressed itself in all his actions. The same spirit also inspired the movement of the 'Free School' which was the forerunner of today's school reform.

In this liberal atmosphere lived Ernst Mach (born 1838) who was in Vienna as student and as *privatdozent* (1861-64). He returned to Vienna only at an advanced age when a special chair of the philosophy of the inductive sciences was created for him (1895). He was especially intent on cleansing empirical science, and in the first place, physics, of metaphysical notions. We recall his critique of absolute space which made him a forerunner of Einstein, his struggle against the metaphysics of the thing-in-itself and of the concept of substance, and his investigations of the construction of scientific concepts from ultimate elements, namely sense data. In some points the development of science

has not vindicated his views, for instance in his opposition to atomic theory and in his expectation that physics would be advanced through the physiology of the senses. The essential points of his conception however were of positive use in the further development of science. Mach's chair was later occupied by Ludwig Boltzmann (1902-06) who held decidedly empiricist views.

The activity of the physicists Mach and Boltzmann in a philosophical professorship makes it conceivable that there was a lively dominant interest in the epistemological and logical problems that are linked with the foundations of physics. These problems concerning foundations also led toward a renewal of logic. The path towards these objectives had also been cleared in Vienna from quite a different quarter by Franz Brentano (during 1874-80 professor of philosophy in the theological faculty, and later lecturer in the philosophical faculty). As a Catholic priest Brentano understood scholasticism; he started directly from the scholastic logic and from Leibniz's endeavours to reform logic, while leaving aside Kant and the idealist system-builders. Brentano and his students time and again showed their understanding of men like Bolzano (*Wissenschaftslehre*, 1837) and others who were working toward a rigorous new foundation of logic. In particular Alois Hofler (1853-1922) put this side of Brentano's philosophy in the foreground before a forum in which, through Mach's and Boltzmann's influence, the adherents of the scientific world conception were strongly represented. In the Philosophical Society at the University of Vienna numerous discussions took place under Hofler's direction, concerning questions of the foundation of physics and allied! epistemological and logical problems. The Philosophical Society published *Prefaces and Introductions to Classical Works on Mechanics* (1899), as well as the individual papers of Bolzano (edited by Hofler and Hahn, 1914 and 1921). In Brentano's Viennese circle there was the young Alexius von Meinong (1870-82, later professor in Graz), whose theory of objects (1907) has certainly some affinity to modern theories of concepts and whose pupil Ernst Mally (Graz) also worked in the field of logics. The early writings of Hans Pichler (1909) also belong to these circles.

Roughly at the same time as Mach, his contemporary and friend Jose Popper-Lynkeus worked in Vienna. Beside his physical and technical achievements we mention his large-scale, if unsystematic philosophical reflections (1899) and his rational economic plan (*A General Peacetime Labour Draft*, 1878). He consciously served the spirit of enlightenment, as is also evident from his book on Voltaire. His rejection of metaphysics was shared by many other Viennese sociologists, for example Rudolf Goldscheid. It is remarkable that in the field of political economy, too, there was in Vienna a strictly scientific method, used by the marginal utility school (Carl Menger, 1871); this method took root in England, France and Scandinavia, but not in Germany. Marxist theory likewise was cultivated and extended with special emphasis in Vienna (Otto Bauer, Rudolf Hilferding, Max Adler and others).

These influences from various sides had the result, especially since 1900, that there was in Vienna a sizeable number of people who frequently and assiduously discussed more general problems in close connection with empirical sciences. Above all these were epistemological and methodological problems of physics, for instance Poincare's

conventionalism, Duhem's conception of the aim and structure of physical theories (his translator was the Viennese Friedrich Adler, a follower of Mach, at that time *privatdozent* in Zurich); also questions about the foundations of mathematics, problems of axiomatics, logistic and the like. The following were the main strands from the history of science and philosophy that came together here, marked by those of their representatives whose works were mainly read and discussed:

(1) Positivism and empiricism: Hume, Enlightenment, Comte, J. S. Mill, Richard Avenarius, Mach.

(2) Foundations, aims and methods of empirical science (hypotheses in physics, geometry, etc.): Helmholtz, Riemann, Mach, Poincare, Enriques, Duhem, Boltzmann, Einstein.

(3) Logistic and its application to reality: Leibniz, Peano, Frege, Schroder, Russell, Whitehead, Wittgenstein.',

(4) Axiomatics: Pasch, Peano, Vailati, Pieri, Hilbert.

(5) Hedonism and positivist sociology: Epicurus, Hume, Bentham,

J. S. Mill, Comte, Feuerbach, Marx, Spencer, Mtiler-Lyer, Popper- Lynkeus, Carl Menger (the elder).

1.2. The Circle around Schlick .

In 1922 Moritz Schlick was called from Kiel to Vienna. His activities fitted well into the historical development of the Viennese scientific, atmosphere. Himself originally a physicist, he awakened to new life the tradition that had been started by Mach and Boltzmann and, in a certain sense, carried on by the anti-metaphysically inclined Adolf Stohr. (In Vienna successively: Mach, Boltzmann, Stehr, Schlick; in Prague: Mach, Einstein, Philipp Frank.) .

Around Schlick, there gathered in the course of time a circle whose members united various endeavours in the direction of a scientific conception of the world. This concentration produced a fruitful mutual inspiration. Not one of the members is a so-called 'pure' philosopher; all of them have done work in a special field of science. Moreover they come from different branches of science and originally from different philosophic attitudes. But over the years growing uniformity appeared; this too was a result of the specifically scientific attitude: "What can be said at all, can be said clearly" (Wittgenstein); if there are differences of opinion, it is in the end possible to agree, and therefore agreement is demanded. It became increasingly clearer that a position not only free from metaphysics, but opposed to metaphysics was the common goal of all.

The attitudes toward questions of life also showed a noteworthy agreement, although these questions were not in the foreground of themes discussed within the Circle. For

these attitudes are more closely related to the scientific world-conception than it might at first glance appear from a purely theoretical point of view.:For instance, endeavours toward a new organization of economic and social relations, toward the unification of mankind, toward a reform of school and education, all show an inner link with the scientific world-conception; it appears that these endeavours are welcomed and regarded with sympathy by the members of the Circle, some of whom indeed actively further them.

The Vienna Circle does not confine itself to collective work as a closed group. It is also trying to make contact with the living movements of the present, so far as they are well disposed toward the scientific world-conception and turn away from metaphysics and theology. The Ernst Mach Society is today the place from which the Circle speaks to a wider public. This society, as stated in its program, wishes to "further and disseminate the scientific world-conception. It will organize lectures and publications about the present position of the scientific world-conception, in order to demonstrate the significance of exact research for the social sciences and the natural sciences. In this way intellectual tools should be formed for modern empiricism, tools that are also needed in forming public and private life." By the choice of its name, the society wishes to describe its basic orientation: science free of metaphysics. This, however, does not mean that the society declares itself in programmatic agreement with the individual doctrines of Mach. The Vienna Circle believes that in collaborating with the Ernst Mach Society it fulfils a demand of the day: we have to fashion intellectual tools for everyday life, for the daily life of the scholar but also for the daily life of all those who in some way join in working at the conscious re-shaping of life. The vitality that shows itself in the efforts for a rational transformation of the social and economic order, permeates the movement for a scientific world-conception too. It is typical of the present situation in Vienna that when the Ernst Mach Society was founded in November 1928, Schlick was chosen chairman; round him the common work in the field of the scientific world-conception had concentrated most strongly.

Schlick and Philipp Frank jointly edit the collection of *Monographs on the Scientific World-Conception [Schriften zur wissenschaftlichen Weltauffassung]* in which members of the Vienna Circle preponderate.

2. THE SCIENTIFIC WORLD CONCEPTION

The scientific world conception is characterised not so much by theses of its own, but rather by its basic attitude, its points of view and direction of research. The goal ahead is *unified science*. The endeavour is to link and harmonise the achievements of individual investigators in their various fields of science. From this aim follows the emphasis on *collective efforts*, and also the emphasis on what can be grasped intersubjectively; from this springs the search for a neutral system of formulae, for a symbolism freed from the slag of historical languages; and also the search for a total system of concepts. Neatness and clarity are striven for, and dark distances and unfathomable depths rejected. In science there are no 'depths'; there is surface everywhere: all experience forms a complex network, which cannot always be surveyed and can often be grasped only in parts.

Everything is accessible to man; and **man is the measure of all things. Here is an affinity with the Sophists, not with the Platonists'**; with the Epicureans, not with the Pythagoreans; with all those who stand for earthly being and the here and now. The scientific world-conception knows *no unsolvable riddle*. Clarification of the traditional philosophical problems leads us partly to unmask them as pseudo-problems, and partly to transform them into empirical problems and thereby subject them to the judgment of experimental science. The task of philosophical work lies in this clarification of problems and assertions, not in the propounding of special 'philosophical' pronouncements. The method of this clarification is that of *logical analysis*; of it, Russell says (*Our Knowledge of the External World*, p. 4) that it "has gradually crept into philosophy through the critical scrutiny of mathematics... It represents, I believe, the same kind of advance as was introduced into physics by Galileo: the substitution of piecemeal, detailed and verifiable results for large untested generalities recommended only by a certain appeal to imagination."

It is *the method of logical analysis* that essentially distinguishes recent empiricism and positivism from the earlier version that was more biological-psychological in its orientation. If someone asserts "there is a God", "the primary basis of the world is the unconscious", "there is an entelechy which is the leading principle in the living organism"; we do not say to him: "what you say is false"; but we ask him: "what do you mean by these statements?" Then it appears that there is a sharp boundary between two kinds of statements. To one belong statements as they are made by empirical science; their meaning can be determined by logical analysis or, more precisely, through reduction to the simplest statements about the empirically given. The other statements, to which belong those cited above, reveal themselves as empty of meaning if one takes them in the way that metaphysicians intend. One can, of course, often re-interpret them as empirical statements; but then they lose the content of feeling which is usually essential to the metaphysician. The metaphysician and the theologian believe, thereby misunderstanding themselves, that their statements say something, or that they denote a state of affairs. Analysis, however, shows that these statements say nothing but merely express a certain mood and spirit. To express such feelings for life can be a significant task. But the proper medium for doing so is art, for instance lyric poetry or music. It is dangerous to choose the linguistic garb of a theory instead: a theoretical content is simulated where none exists. If a metaphysician or theologian wants to retain the usual medium of language, then he must himself realise and bring out clearly that he is giving not description but expression, not theory or communication of knowledge, but poetry or myth. If a mystic asserts that he has experiences that lie above and beyond all concepts, one cannot deny this. But the mystic cannot talk about it, for talking implies capture by concepts and reduction to scientifically classifiable states of affairs.

The scientific world-conception rejects metaphysical philosophy. But how can we explain the wrong paths of metaphysics? This question may be posed from several points of view: psychological, sociological and logical. Research in a psychological direction is still in its early stages; the beginnings of more penetrating explanation may perhaps be seen in the investigations of Freudian psychoanalysis. The state of sociological

investigation is similar; we may mention the theory of the 'ideological superstructure'; here the field remains open to worthwhile further research.

More advanced is the clarification of *the logical origins of metaphysical aberration*, especially through the works of Russell and Wittgenstein. In metaphysical theory, and even in the very form of the questions, there are two basic logical mistakes: too narrow a tie to the form of *traditional languages* and a confusion about the logical achievement of thought. Ordinary language for instance uses the same part of speech, the substantive, for things ('apple') as well as for qualities ('hardness'), relations ('friendship'), and processes ('sleep'); therefore it misleads, one into a thing-like' conception of functional concepts (hypostasis, substantialization). One can quote countless similar examples of linguistic misleading, that have been equally fatal to philosophers.

The second basic error of metaphysics consists in the notion that *thinking* can either lead to knowledge out of its own resources without using any empirical material, or at least arrive at new contents by an inference from given states of affair. Logical, investigation, however, leads to the result that all thought and inference consists 'of nothing but a transition from statements to other statements that contain nothing that was not already in the former (tautological transformation). It is therefore not possible to develop a metaphysic from 'pure thought'.

In such a way logical analysis overcomes not only metaphysics in the proper, classical sense of the word, especially scholastic metaphysics and that of the systems of German idealism, but also the hidden metaphysics of Kantian and modern *apriorism*. The scientific world-conception knows no unconditionally valid knowledge derived from pure reason, no 'synthetic judgments a priori' of the kind that lie at the basis of Kantian epistemology and even more of all pre- and post-Kantian ontology and metaphysics. The judgments of arithmetic, geometry, and certain fundamental principles of physics, that Kant took as examples of a priori knowledge will be discussed later. It is precisely in the rejection of the possibility of 'synthetic knowledge a priori' that the basic thesis of modern empiricism lies. The scientific world-conception knows only empirical statements about things of all kinds, and analytic statements of logic and mathematics.

In rejecting overt metaphysics and the concealed variety of apriorism, all adherents of the scientific world-conception are at one. Beyond this, the Vienna Circle maintain the view that the statements of (critical) *realism* and *idealism* about the reality or non-reality of the external world and other minds are of a metaphysical character, because they are open to the same objections as are the statements of the old metaphysics: they are meaningless, because unverifiable and without content. For us, *something is 'real' through being incorporated into the total structure of experience*.

Intuition which is especially emphasised by metaphysicians as a source of knowledge, is not rejected as such by the scientific world-conception. However, rational justification has to pursue all intuitive knowledge step by step. The seeker is allowed any method; but what has been found must stand up to testing. The view which attributes to intuition a superior and more penetrating power of knowing, capable of leading beyond the contents

of sense experience and not to be confined by the shackles of conceptual thought - this view is rejected.

We have characterised the *scientific world-conception* essentially by *two features*. *First* it is *empiricist and positivist*: there is knowledge only from experience, which rests on what is immediately given. This sets the limits for the content of legitimate science. *Second*, the scientific world-conception is marked by application of a certain method, namely *logical analysis*. The aim of scientific effort is to reach the goal, unified science, by applying logical analysis to the empirical material. Since the meaning of every statement of science must be statable by reduction to a statement about the given, likewise the meaning of any concept, whatever branch of science it may belong to, must be statable by step-wise reduction to other concepts, down to the concepts of the lowest level which refer directly to the given. If such an analysis were carried through for all concepts, they would thus be ordered into a reductive system, a 'constitutive system'. Investigations towards such a constitutive system, the 'constitutive theory', thus form the framework within which logical analysis is applied by the scientific world-conception. Such investigations show very soon that traditional Aristotelian scholastic logic is quite inadequate for this purpose. Only modern symbolic logic ('logistic') succeeds in gaining the required precision of concept definitions and of statements, and in formalizing the intuitive process of inference of ordinary thought, that is to bring it into a rigorous automatically controlled form by means of a symbolic mechanism. Investigations into constitutive theory show that the lowest layers of the constitutive system contain concepts of the experience and qualities of the individual psyche; in the layer above are physical objects; from these are constituted other minds and lastly the objects of social science. The arrangement of the concepts of the various branches of science into the constitutive system can already be discerned in outline today, but much remains to be done in detail. With the proof of the possibility and the outline of the shape of the total system of concepts, the relation of all statements to the given and with it the general structure of *unified science* become recognisable too.

A scientific description can contain only the *structure* (form of order) of objects: not their 'essence'. What unites men in language are structural formulae; in them the content of the common knowledge of men presents itself. Subjectively experienced qualities - redness, pleasure - are as such only experiences, not knowledge; physical optics admits only what is in principle understandable by a blind man too.

3. FIELDS OF PROBLEMS

3.1. *Foundations of Arithmetic*

In the writings and discussions of the Vienna Circle many different problems are treated, stemming from various branches of science. Attempts are made to arrange the various lines of problems systematically, and thereby to clarify the 'situation'.

The problems concerning the foundations of arithmetic have become of special historical significance for the development of the scientific world-conception because they gave

impulse to the development of a new logic. After the very fruitful developments of mathematics in the 18th and 19th century during which more attention was given to the wealth of new results than to subtle examination of their conceptual foundations, this examination became unavoidable if mathematics were not to lose the traditionally celebrated certainty of its structure. This examination became even more urgent when certain contradictions, the 'paradoxes of set theory', arose. It was soon recognized that these were not just difficulties in a special part of mathematics, but rather they were general logical contradictions, 'antinomies', which pointed to essential mistakes in the foundations of traditional logic. The task of eliminating these contradictions gave a very strong impulse to the further development of logic. Here efforts for *clarification of the concept of number* met with those for an internal *reform of logic*. Since Leibniz and Lambert, the idea had come up again and again to master reality through a greater precision of concepts and inferential processes, and to obtain this precision by means of a symbolism fashioned after mathematics. After Boole, Venn and others, especially Frege (1884), Schroder (1890) and Peano (1895) worked on this problem. On the basis of these preparatory efforts *Whitehead* and *Russell* (1910) were able to establish a coherent system of logic in symbolic form ('logistic'), not only avoiding the contradictions of traditional logic, but far exceeding that logic in intellectual wealth and practical applicability. From this logical system they derived the concepts of arithmetic and analysis, thereby giving mathematics a secure foundation in logic.

Certain difficulties however remained in this attempt at overcoming the foundation crisis of arithmetic (and set theory) and have so far not found a definitively satisfactory solution. At present three different views confront each other in this field; besides the 'logicism' of Russell and Whitehead, there is Hilbert's 'formalism' which regards arithmetic as a playing with formulae according to certain rules, and Brouwer's 'intuitionism' according to which arithmetic knowledge rests on a not further reducible intuition of duality and unity [*Zwei-einheit*]. The debates are followed with great interest in the Vienna Circle. Where the decision will lead in the end cannot yet be foreseen; in any case, it will also imply a decision about the structure of logic; hence the importance of this problem for the scientific world-conception. Some hold that the three views are not so far apart as it seems. They surmise that essential features of all three will come closer in the course of future development and probably, using the far-reaching ideas of Wittgenstein, will be united in the ultimate solution.

The conception of mathematics as tautological in character, which is based on the investigations of Russell and Wittgenstein, is also held by the Vienna Circle. It is to be noted that this conception is opposed not only to apriorism and intuitionism, but also to the older empiricism (for instance of J. S. Mill), which tried to derive mathematics and logic in an experimental-inductive manner as it were.

Connected with the problems of arithmetic and logic are the investigations into the nature of the *axiomatic method* in general (concepts of completeness, independence, monomorphism, unambiguity and so on) and on the establishment of axiom-systems for certain branches of mathematics.

3.2. Foundations of Physics

Originally the Vienna Circle's strongest interest was in the method of empirical science. Inspired by ideas of Mach, Poincare, and Duhem, the problems of mastering reality through scientific systems, especially through *systems of hypotheses and axioms*, were discussed. A system of axioms, cut loose from all empirical application, can at first be regarded as a system of implicit definitions; that is to say, the concepts that appear in the axioms are fixed, or as it were defined, not from their content but only from their mutual relations through the axioms. Such a system of axioms attains a meaning for reality only by the addition of further definitions, namely the 'coordinating definitions', which state what objects of reality are to be regarded as members of the system of axioms. The development of empirical science, which is to represent reality by means of as uniform and simple a net of concepts and judgments as possible, can now proceed in one of two ways, as history shows. The changes imposed by new experience can be made either in the axioms or in the coordinating definitions. Here we touch the problem of conventions, particularly treated by Poincare. '

The methodological problem of the application of axiom systems to reality may in principle arise for any branch of science. That these investigations have thus far been fruitful almost solely for physics, however, can be understood from the present stage of historical development of science: in regard to precision and refinement of concepts; physics is far ahead of the other branches of science.

Epistemological analysis of the leading concepts of natural science has freed them more and more from *metaphysical admixtures* which had clung to them from ancient time. In particular, Helmholtz, Mach, Einstein, and others have cleansed the concepts of *space, time, substance, causality, and probability*. The doctrines of absolute space and time have been overcome by the theory of relativity; space and time are no longer absolute containers but only ordering manifolds for elementary processes. Material substance has been dissolved by atomic theory and field theory. Causality was divested of the anthropomorphic character of 'influence' or 'necessary connection' and reduced to a relation among conditions, a functional coordination. Further, in place of the many laws of nature which were considered to be strictly valid, statistical laws have appeared; following the quantum theory there is even doubt whether the concept of strictly causal lawfulness is applicable to phenomena in very small space-time regions. The concept of probability is reduced to the empirically graspable concept of relative frequency.

Through the application of the *axiomatic method* to these problems, the empirical components always separate from the merely conventional ones, the content of statements from definitions. No room remains for a priori synthetic judgments. That knowledge of the world is possible rests not on human reason impressing its form on the material, but on the material being ordered in a certain way. The kind and degree of this order cannot be known beforehand. The world might be ordered much more strictly than it is; but it might equally be ordered much less without jeopardising the possibility of knowledge. Only step by step can the advancing research of empirical science teach us in what degree the world is regular. The method of induction, the inference from yesterday

to tomorrow, from here to there, is of course only valid if regularity exists. But this method does not rest on some a priori presupposition of this regularity. It may be applied wherever it leads to fruitful results, whether or not it be adequately founded; it never yields certainty. However, epistemological reflection demands that an inductive inference should be given significance only insofar as it can be tested empirically. The scientific world-conception will not condemn the success of a piece of research because it has been gathered by means that are inadequate, logically unclear or empirically unfounded. But it will always strive at testing with clarified aids, and demand an indirect or direct reduction to experience.

3.3. Foundations of Geometry

Among the questions about the foundations of physics, the problem of *physical space* has received special significance in recent decades. The investigations of Gauss (1816), Bolyai (1823), Lobatchevski (1835) and others led to *non-Euclidean geometry*, to a realisation that the hitherto dominant classical geometric system of Euclid was only one of an infinite set of systems, all of equal logical merit. This raised the question, which of these geometries was that of actual space. Gauss had wanted to resolve this question by measuring the angles of a large triangle. This made *physical geometry* into an empirical science, a branch of physics. The problems were further studied particularly by Riemann (1868), Helmholtz (1868) and Poincare (1904). Poincare especially emphasised the link of physical geometry with all other branches of physics: the question concerning the nature of actual space can be answered only in connection with a total system of physics. Einstein then found such a total system, which answered the question in favour of a certain non-Euclidean system.

Through this development, physical geometry became more and more clearly separated from pure *mathematical* geometry. The latter gradually became more and more formalised through further development of logical analysis. First it was arithmetised, that is, interpreted as the theory of a certain number system. Next it was axiomatised, that is, represented by means of a system of axioms that conceives the geometrical elements (points, etc.) as undefined objects, and fixes only their mutual relations. Finally geometry was logicised, namely represented as a theory of certain structural relations. Thus geometry became the most important field of application for the axiomatic method and for the general theory of relations. In this way, it gave the strongest impulse to the development of the two methods which in turn became so important for the development of logic itself, and thereby again for the scientific world-conception.

The relations between mathematical and physical geometry naturally led to the problem of the application of axiom systems to reality which, as mentioned, played a big role in the more general investigations about the foundations of physics.

3.4. Problems of the Foundations of Biology and Psychology

Metaphysicians have always been fond of singling out biology as a special field. This came out in the doctrine of a special life force, the theory of *vitalism*. The modern

representatives of this theory endeavour to bring it from the unclear, confused form of the past into a conceptually clear formulation. In place of the life force, we have 'dominants' (Reinke, 1899) or 'entetechies' (Driesch, 1905). Since these concepts do not satisfy the requirement of reducibility to the given, the scientific world-conception rejects them as metaphysical. The same holds true of so-called 'psychovitalism' which puts forward an intervention of the soul, a 'role of leadership of the mental in the material'. If, however, one digs out of this metaphysical vitalism the empirically graspable kernel, there remains the thesis that the processes of organic nature proceed according to laws that cannot be reduced to physical laws. A more precise analysis shows that this thesis is equivalent to the assertion that certain fields of reality are not subject to a uniform and pervasive regularity.

It is understandable that the scientific world-conception can show more definite confirmation for its views in those fields which have already achieved conceptual precision than in others: in physics more than in psychology. The linguistic forms which we still use in psychology today have their origin in certain ancient metaphysical notions of the soul. The formation of concepts in psychology is made difficult by these defects of language: metaphysical burdens and logical incongruities. Moreover there are certain factual difficulties. The result is that hitherto most of the concepts used in psychology are inadequately defined; of some, it is not known whether they have meaning or only simulate meaning through usage. So, in this field nearly everything in the way of epistemological analysis still remains to be done; of course, analysis here is more difficult than in physics. The attempt of behaviorist psychology to grasp the psychic through the behavior of bodies, which is at a level accessible to perception, is, in its principled attitude, close to the scientific world conception.

3.5. Foundations of the Social Sciences

As we have specially considered with respect to physics and mathematics, every branch of science is led to recognise that, sooner or later in its development, it must conduct an epistemological examination of its foundations, a logical analysis of its concepts. So too with the social sciences, and in the first place with history and economics. For about a hundred years, a process of elimination of metaphysical admixtures has been operating in these fields. Of course the purification has not yet reached the same degree as in physics; on the other hand, the task of cleansing is less urgent perhaps. For it seems that even in the heyday of metaphysics and theology, the metaphysical strain was not particularly strong here; maybe this is because the concepts in this field, such as war and peace, import and export, are closer to direct perception than concepts like atom and ether. It is not too difficult to drop concepts like 'folk spirit' and instead to choose, as our object, groups of individuals of a certain kind. Scholars from the most diverse trends, such as Quesnay, Adam Smith, Ricardo, Comte, Marx, Menger, Walras, Miiller-Lyer, have worked in the sense of the empiricist, anti-metaphysical attitude. The object of history and economics are people, things and their arrangement.

4. RETROSPECT AND PROSPECT

The modern scientific world-conception has developed from work on the problems just mentioned. We have seen how in physics, the endeavours to gain-tangible results, at first even with inadequate or still insufficiently clarified scientific tools, found itself forced more and more into methodological investigations. Out of this developed the method of forming hypotheses and, further, the axiomatic method and logical analysis; thereby concept formation gained greater clarity and strength. The same methodological problems were met also in the development of foundations research in physical geometry, mathematical geometry and arithmetic, as we have seen. It is mainly from all these sources that the problems arise with which representatives of the scientific world-conception particularly concern themselves at present. Of course it is still clearly noticeable from which of the various problem areas the individual members of the Vienna Circle come. This often results in differences in lines of interests and points of view, which in turn lead to differences in conception. But it is characteristic that an endeavour toward precise formulation, application of an exact logical language and symbolism, and accurate differentiation between the theoretical content of a thesis and its mere attendant notions, diminish the separation. Step by step the common fund of conceptions is increased, forming the nucleus of a scientific world-conception around which the outer layers gather with stronger subjective divergence.

Looking back we now see clearly what is the *essence of the new scientific world-conception* in contrast with traditional philosophy. No special 'philosophic assertions' are established, assertions are merely clarified; and at that assertions of 'empirical science, as we' have seen when we discussed the various problem areas. Some representatives of the scientific world-conception no longer want to use the term 'philosophy' for their work at all, so as to emphasise the contrast with the philosophy of (metaphysical) systems even more strongly. Whichever term may be used to describe such investigations, this much is certain: *there is no such thing as philosophy as a basic or universal science alongside or above the various fields of the one empirical science; there is no way to genuine knowledge other than the way of experience; there is no realm of ideas that stands over or beyond experience.* Nevertheless the work of 'philosophic' or 'foundational' investigations remains important in accord with the scientific world-conception. For the logical clarification of scientific concepts, statements and methods liberates one from inhibiting prejudices. Logical and epistemological analysis does not wish to set barriers to scientific enquiry; on the contrary, analysis provides science with as complete a range of formal possibilities as is possible, from which to select what best fits each empirical finding (example: non-Euclidean geometries and the theory of relativity).

The representatives of the scientific world-conception resolutely stand on the ground of simple human experience. They confidently approach the task of removing the metaphysical and theological debris of millennia. Or, as some have it: returning, after a metaphysical interlude, to a unified picture of this world which had, in a sense, been at the basis of magical beliefs, free from theology, in the earliest times.

The increase of metaphysical and theologizing leanings which shows itself today in many associations and sects, in books and journals, in talks and university lectures, seems to be based on the fierce social and economic struggles of the present: one group of

combatants, holding fast to traditional social forms, cultivates traditional attitudes of metaphysics and theology whose content has long since been superseded; while the other group, especially in central Europe, faces modern times, rejects these views and takes its stand on the ground of empirical science. This development is connected with that of the modern process of production, which is becoming ever more rigorously mechanised and leaves ever less room for metaphysical ideas. It is also connected with the disappointment of broad masses of people with the attitude' of those who preach traditional metaphysical and theological doctrine. So it is that in many countries the masses now reject these doctrines much more consciously than ever before, and along with their socialist attitudes tend to lean towards a down-to-earth empiricist view. In previous times, *materialism* was the expression of this view; meanwhile, however, modern empiricism has shed a number of inadequacies and has taken a strong shape in the *scientific world-conception*.

Thus, the scientific world-conception is close to the life of the present. Certainly it is threatened with hard struggles and hostility. Nevertheless there are many who do not despair but, in view of the present sociological situation, look forward with hope to the course of events to come. Of course not every single adherent of the scientific world-conception will be a fighter. Some, glad of solitude, will lead a withdrawn existence on the icy slopes of logic; some may even disdain mingling with the masses and regret the 'trivialized' form that these matters inevitably take on spreading. However, their achievements too will take a place among the historic developments. We witness the spirit of the scientific world-conception penetrating in growing measure the forms of personal and public life, in education, upbringing, architecture, and the shaping of economic and social life according to rational principles. *The scientific world-conception serves life, and life receives it.*

1. Members of the Vienna Circle

Gustav Bergmann

Rudolf Carnap

Herbert Feigl

Philipp Frank

Kurt Godel

Hans Hahn

Viktor Kraft

Karl Menger

Marcel Natkin

Otto Neurath

Olga Hahn-Neurath

Theodor Radakovic

Moritz Schlick

Friedrich Waismann

2. Those sympathetic to the Vienna Circle

Walter Dubislav

Josef Frank

Kurt Grelling

Hasso Hiirlen

E. Kaila

Heinrich Loewy

F. P. Ramsey

Hans Reichenbach

Kurt Reidemeister

Edgar Zilsel

3. Leading representatives of the scientific world-conception

Albert Einstein

Bertrand Russell

Ludwig Wittgenstein

REFERENCES

1 [1929, Bibl. No. 179- Ed.].

a [The pamphlet *Wissenschaftliche Weltauffassung, Der Wiener Kreis* does not give an author's name on the title page - unless one considers 'Der Wiener Kreis' as author, being

printed in smaller type. This pamphlet is the product of teamwork; Neurath did the writing, Hahn and Carnap edited the text with him; other members of the Circle were asked for their comments and contributions. (H. Feigl mentions F. Waismann and himself, see: 'Wiener Kreis in America' in *Perspectives in American History*, 11, 1968.) See also H. Neurath's remarks in his contribution to our first chapter; he was a witness, as I was myself. (The publisher, Artur Wolf, also published the first colour book of the Social and Economic Museum in Vienna.) Carnap and Hahn's widow gave us their permission to include the pamphlet among Otto Neurath's writings. In fact, the name Wiener Kreis (Vienna Circle) was invented and suggested by Neurath. (See the Neurath-Carnap correspondence in a later volume in this series.)- M.N.]

3 [Note: In his text, Russell wrote about 'logical atomism', not specifically of 'logical analysis' - Trans.].