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Chapter Three

Metaphysical and Scientific Realism

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Discussion of realism and anti-realism is very widespread in contemporary philosophy. But this debate has not proven very fruitful, for the simple reason that little agreement can be found on the meaning of the fundamental concepts involved. These differences are not just a matter of personal idiosyncrasies, but are rather the often unconscious consequence of a mixture of different-meaning elements that have been attached to realism during the whole history of Western philosophy. For this reason, it will be useful briefly to summarize the salient features of this historical development.

Realism in 'classical' philosophy

The notion of realism has had two basic meanings in the history of Western philosophy: the first emerged in the 'dispute about universals' of the Middle Ages and concerned the 'kind of existence' that can be attributed to universals, such as genera and species. It is, therefore, an ontological question. In this dispute no one denied that 'full reality' should be attributed to so-called 'individual substances' that 'exist in themselves', such as stones, trees, men, and women, but also God, angels, and devils. The issue concerned only the real existence of such 'abstract entities' as genera and species, that we commonly denote through general concepts (this is why the dispute was called the 'dispute about universals'). Given this premiss, it has become customary to call 'extreme realists' those philosophers who claimed that universals are 'real', that is, have an existence in themselves, as Plato had said of his Ideas. A different position was advocated by the so-called 'conceptualists' who affirmed that universals are simply concepts and, as such, though endowed with some 'kind of reality', they do not exist 'in themselves', but only in our minds. They have simply a mental reality, that is, a mental existence: they are *entia rationis*, in the terminology of that time. A radical position was taken

by the 'nominalists', who were prepared to grant real existence only to individuals. Nominalists reduced the 'universals' to simple 'names' to which not even a conceptual designatum corresponds: they are only mental (and linguistic) tools for grouping together individuals that show certain similarities. Finally, a fourth position was that of the 'moderate realists' inspired by Aristotelian metaphysics (the most famous representative of which is Thomas Aquinas). According to them universals do not exist 'in themselves', but exist 'in the individual substances' as their 'essence' or 'form' (in the technical Aristotelian sense), as well as 'in our intellect' as concepts.

These different positions were all of a strict ontological or metaphysical kind, and were not rooted in different epistemological doctrines. Indeed, all tacitly shared a common realist epistemology in the following sense: our knowledge is knowledge of reality in its different kinds. Moreover, all admitted that our knowledge is based on sensible intuition and on intellectual intuition, and differed only in the determination of the objects of such intuitions. The extreme realists maintained that genera and species have an ontological subsistence in themselves as immaterial substances, and can be grasped directly by our intellectual intuition. Moderate realists maintained that these universals have no subsistence in themselves, but enter into the ontological constitution of the individual substances as their form, and can be grasped by our intellectual intuition by means of 'abstraction'. Therefore, they have a kind of double existence, or ontological status: on the one hand, they are the ontological constituents that, in conjunction with matter, make up the individual substances; on the other hand, they are present in our intellect as *entia rationis*. The conceptualists limited their position to this second aspect, without feeling committed to a particular doctrine regarding the status of the universals 'outside' the mind. The nominalists considered the intellectual intuition as a kind of reproduction of the sensible intuition, which is, admittedly, intuition only of single individual items of reality and, as a consequence, could not give the universals any consistent ontological status. In conclusion, the different positions can be related to different ways of considering the role of intellectual intuition.

We cannot delay here over the details of the 'analytical ontology' that provided the ground for such discussions. We simply want to stress that a 'realist' attitude was their common framework. This may become even more apparent if we consider that in such ontological disputes the famous issue of 'independence' was also touched upon, but this was by no means conceived as an independence of existence from knowledge. For example, the existence of accidents was said to 'depend' on the existence of the

substance in which they inhere, but not on the activity of the mind that perceives them.

Epistemological dualism

A radical change emerged from a tacit and gratuitous presupposition that characterized 'modern' philosophy (conventionally inaugurated by Descartes), according to which what we immediately know are our representations or ideas, and not 'reality'. Therefore the chief question became that of knowing whether or not, starting from our ideas, we can indirectly attain knowledge of reality. Those who maintained that we can were known as 'realists', while those who maintained that we are condemned to know simply our ideas were known as 'idealists'. Therefore, 'realism' has, in this context, an epistemological meaning. It is obvious that this tacit 'presupposition' actually contained a second: that 'reality' exists independently of our knowledge (a presupposition that can be called 'naturalistic' since it reflects the common-sense conviction that there is a Nature 'external' to our mind, and at the same time constitutes the presupposition of natural science, whose spontaneous aim is that of investigating and knowing the features of this Nature). As a consequence the majority of modern philosophers until the end of the eighteenth century can be qualified as 'realist' in the weak ontological sense of admitting (in keeping with common sense) that there exists a reality 'external' to our mind, whose existence is independent of our mind (external things are not created or posited by our mind); while they were also 'idealist' in the weak epistemological sense of affirming that we do not directly know reality, but only our ideas. Therefore the open question remained that of establishing whether or not we can also attain an (indirect) knowledge of reality starting from our ideas, that is, whether or not we can know how reality is, what it is like. From this second point of view, the realists are those philosophers who believed that a positive answer may be given to this question, and idealists are those who did not see the possibility of transcending the realm of our ideas to reach reality. Before the end of the eighteenth century only Berkeley, among the best-known philosophers, expressed the full and radical idealist position, in which the 'ontological dependence' of things on our ideas is explicitly affirmed: *esse est percipi* ('to be is to be the content of a perception'). In the nineteenth century the so-called 'transcendental idealism' of Fichte, Schelling and, especially, Hegel, arrived at the extreme conclusion of claiming the 'ontological identity' of reality and thought, in the sense that reality 'reduces' to thought.

All these are quite well-known facts, and we have recalled them only to stress that they are a consequence of the 'dualistic presupposition' mentioned before. The interesting point is to state the crucial difference that divides 'classical' from 'modern' epistemology. This difference can be summarized as follows: according to classical epistemology knowledge consists in the fact that things are present to the mind; according to modern epistemology knowledge consists in the fact that things are only (at best) represented by the mind. Moreover, this presence was not to be conceived of in any spatial sense, and this conception was expressed through the notion of a particular 'identity', the intentional identity of thought and reality: in a perception or in an intellectual intuition our cognitive capacities 'identify' themselves with the objects, though remaining ontologically distinct from them. This ontological distinction furnishes the correct meaning of the 'external' world which, otherwise, would reduce to the almost ridiculous notion of all that lies 'outside of my skin'. The representation, from this point of view, simply is 'the way of being present' of a given thing to our cognitive capacities, and 'depends' in an ontological sense on both, but not in the sense of being 'produced' by either of them.

Modern epistemology, having lost the notion of 'intentional identity', gives representations the status of direct objects of knowledge that we encounter in our mind. Therefore a spontaneous question is: from where do our ideas come? This famous problem of the 'origin of ideas' has concerned many modern philosophers, but is as gratuitous as the dualistic presupposition itself. Indeed, why should we believe that our ideas 'come from' anything else? The answer to this ill-posed question was sought along two equally unsatisfactory paths of causal explanation. The so-called 'rationalists' maintained that our basic ideas are innate and are put into our mind (they are caused) directly by God. The 'empiricists' maintained that our basic ideas are causally produced by a physical action of things on our sense organs. Both proposals had their peculiar difficulties, that are presented in any textbook of the history of philosophy, and need not be recalled here. It is worth noting that the conviction that our representations could with luck be a copy of, or have a 'similitude' with other things is a typical consequence of the 'epistemological presupposition' and characterizes, therefore, modern philosophy, while it cannot be correctly attributed to classical epistemology, according to which things, and not their alleged copies, were intentionally present in the mind.

Metaphysical realism

The expression 'metaphysical realism' is known for having been used by Putnam, who means by it the philosophical perspective according to which

the world consists of some fixed totality of mind-independent objects. There is exactly one true and complete description of 'the way the world is'. Truth involves some sort of correspondence relation between words or thought-signs and external things and sets of things.

He calls this perspective 'the *externalist* perspective, because its favourite point of view is a God's Eye point of view'.¹ It may seem a little mysterious that such a perspective should be called realist in a 'metaphysical' sense. But we can venture to propose an historical explanation of this fact. The term 'metaphysics' in the 'classical' sense had two distinct shades of meaning (which are already present in Aristotle): on the one hand it designated the doctrine of 'reality as such' (that is, of the most general characteristics of being); on the other hand it designated the doctrine of those dimensions of reality that transcend the domain of sensible experience. Logical empiricists of the Vienna Circle were programmatically against metaphysics, which they intended concretely in the second sense (for them, any discourse transcending sense experience is 'meaningless'). Analytical philosophy, however, which to a certain extent can be seen as derived from logical empiricism, gradually recovered at least in part the first meaning of classical metaphysics, and legitimated a so-called 'descriptive metaphysics', which is intended to be a study of the general features of empirically accessible reality (leaving aside those developments that had led classical metaphysics to affirm the existence, and describe some characteristics, of meta-empirical or transcendent reality). It is not without interest that some of the thinkers who have worked in the framework of this descriptive metaphysics have gradually rediscovered several concepts and principles of Aristotelian metaphysics (Strawson and Wiggins are good examples). This position can be characterized by two 'realist' attitudes: 'ontological realism' (reality exists in itself and is independent of our knowledge of it), and 'epistemological realism' (we are able to know what reality is like or 'the way the world is'). If we focus our attention on these two basic features, Putnam's concept of 'metaphysical realism' does not appear mysterious, for it can be related to a conception and terminology that are significantly present in contemporary English language philosophy. Yet it is doubtful that the additional claims he attributes to the metaphysical realist are correctly

attributed to him. In fact he adds to the usual claim that the world consists of some totality of mind-independent objects (ontological requirement), the gratuitous pretension that this totality is 'fixed' (without explaining what this actually means). The claim that 'there is just one true and complete description of the way the world is' is again excessive, because it presupposes that the metaphysical realist necessarily advocates a one-to-one correspondence between elements, properties, relations of the world and fixed terms of the language (which is, at best, a rough form of logical atomism). Finally the epistemological claim is made that the metaphysical realist would identify adequate knowledge of reality with the 'God's Eye point of view'. If all these features were joined together it would be hard to find a single 'metaphysical realist' in the history of philosophy. It would not be difficult to show that these additional alleged requirements depend on a conflation of ontological, epistemological, semantic, and linguistic issues that, though often being mixed up in discussions of realism, ought to be carefully distinguished. We are not interested, however, in criticizing Putnam now, since we are more interested in proposing what we believe to be a more adequate definition of metaphysical realism.

We propose to call 'metaphysical realism' simply the position that does not subscribe to the two uncritical and dogmatic presuppositions mentioned above, that is, that we directly know only our representations, and that there is a reality hidden behind these representations. No evidence or argument has ever been proposed for such claims, and we can, on the contrary, maintain that reality is present to our senses and thinking. The burden of proof lies with those who claim that what is present is not reality, but something else. It is not easy to see how they could substantiate it. Indeed, unless one conceives of reality in a naive and purely pictorial sense, as something mysterious lying behind what is present to our knowing capability, reality simply means the totality of what is real, and real is, in turn, anything that is different from nothing. Therefore, to say that thinking or knowing is not thinking or knowing reality amounts to saying that we think or know nothing, and this amounts to having no thinking or knowledge at all. All this does not entail that the whole of reality is present in every act of knowledge. On the contrary, only certain aspects or attributes of reality are present in our acts of knowledge (only colours and shapes can be present to our visual perceptions, and not sounds or smells, for example; moreover, only a single colour and a single shape are present in a single accurately focused act of vision). Since human beings are endowed with cognitive capabilities that overstep those of other living beings (let us call them intellectual capabilities for brevity), it is absolutely obvious that certain

features or attributes of reality can be present to our intellect, and these are those features that we call universal or abstract. If we call 'intuition' the immediate presence of something to our cognitive capabilities, we must conclude that, besides sensible intuition, we are endowed also with intellectual intuition.

The characterization of realism we have defended thus far can be summarized as the thesis of the 'knowability and intelligibility of reality'. This does not mean, we repeat, that the whole of reality is actually known or even totally accessible to our knowledge. Therefore this realism is external in Putnam's sense, but does not coincide at all with a 'God's Eye view'. Why then do we call it 'metaphysical'? The reason is that, while admitting that what is immediately known is real, is a part of reality, we admit that the domain of reality is broader than the domain of what is immediately present to our knowledge, since at the same time we recognize that the intellect can lead us to determine features of reality that are not immediately present. Here, again, we are not maintaining that 'the whole of reality' can be disclosed to us, but simply that more of reality can be known than what is immediately present to our sensible and intellectual intuition. This can be obtained by logical inference that relies upon the basic intelligibility of reality and justifies the admission of features of it that are necessary for making it intelligible or, at least, that are sufficient for this purpose (with familiar differences in degrees of certainty). If we call 'experience' the whole of what is immediately present (that is the content of sensible and intellectual intuition), this enterprise corresponds to a transcendence of experience and, since this move is the core of any metaphysics conceived without aprioristic limitations, this explains why the denomination of 'metaphysical realism' is appropriate.

Our claim is that metaphysical realism is not a philosophical position limited to the rational construction of metaphysics in a disciplinary sense, but is a kind of methodological prerequisite for the construction of science as well and, in particular, justifies a scientific realism that is at the same time 'internal' and 'external' in Putnam's sense. It is 'internal' in the sense that only those features of reality are investigated that fall 'within' the criteria of reference, the conceptual schemes, the methodological procedures admitted by a given science, but is also 'external' in the sense that all these 'cognitive tools' do not 'pose' or 'construct' in an ontological sense those attributes of reality to which they refer. Such referents are 'external' to scientific knowledge in an ontological sense.

Historical overview

Modern science was 'realist' from its origins. A non-realist view of it was advocated by Kant for very special reasons, but did not really affect the common appreciation of science until the 'crisis' of the exact sciences that occurred at the end of the nineteenth century. We will briefly substantiate these claims.

The principal reason why Galileo can be rightly considered as the founder of modern science is that he explicitly and consciously stated the conditions for attaining effective knowledge of 'natural substances' (that is, of physical bodies). Instead of trying to 'grasp by speculation the intimate essence' of such substances (which was the condition traditionally required for scientific knowledge in general, but which he declared to be a 'desperate enterprise'), he maintained that we can attain knowledge of 'some of their affections'. This programme is still expressed in the language of classical ontology, in which a 'substance' was characterized by an 'essence' and the possession of certain 'accidents', of which 'affections' represented a particular kind. All this belongs to a realist ontology. Among the accidents of physical bodies Galileo distinguished those that depend on the sensory capabilities of the observer (colours, smells, and so on), and are therefore subjective, from those that are intrinsic to the body (they are the quantifiable and mathematizable qualities), and that he calls, for this reason, 'real accidents'. It is only with these real accidents that natural science is concerned, and it can do this efficaciously by adopting mathematics as a means for describing them. This clearly realist view of natural science is abundantly confirmed throughout Galileo's works, and in particular by his refusal to consider Copernican astronomy simply as a means for more easily 'saving the appearances' of celestial phenomena, rather than as a successful effort to determine the 'real constitution of the universe'.² What can be correctly found in the Galilean assertions is a certain weakening of the force of intellectual intuition (it is no longer credited with the capacity to capture the essence of things). Its role, however, remains primary, since it is only thanks to intellectual intuition that mathematical properties can be determined and described, that mathematical models of physical events can be constructed, and that idealizations of the natural phenomena can be proposed, and these are salient characteristics of Galileo's scientific method. Therefore, he cannot be considered an empiricist because, while declaring that natural science is based on 'sensible experiences and mathematical demonstrations', he also admits that the most significant advances occur when 'the intellect does violence to the senses'.

In the works of Galileo the term 'phenomenon' does not occur, while it is frequently used by Newton. It must be clearly said, however, that Newton's concept of phenomenon is not affected by the 'epistemological dualism' we have described. For him phenomena are simply the 'manifest' characteristics of physical events, and are by no means 'pure appearances'. He simply takes as a basic methodological requirement for what he calls 'natural philosophy' or 'experimental philosophy' the abstention from introducing in this philosophy (that is, in natural science) any 'hidden qualities' that (as he says) traditional philosophers used to posit as contained in the 'substantial forms' of things, in order to provide explanations of the manifest features of things. All this is well in keeping with the views of Galileo (whom Newton mentions with approval on several occasions). With Galileo he also shares the admission of a limited role for intellectual intuition, to the extent that he too recognizes the decisive importance of mathematization in the construction of natural science, but he is much more clearly an empiricist, since the single general laws of physical phenomena are explicitly declared by him to be propositions obtained by 'inductive generalizations' over phenomena, alongside which possible exceptions must be carefully listed. In such a way generality, rather than universality, appears as the salient characteristic of scientific laws, while no ontological necessity is attributed them (again in keeping with Galileo's views).³

Universality and necessity, on the contrary, had been considered as the characteristic features of science (of *episteme*) by the classical tradition, and had remained substantially preserved in the view of science of the 'rationalist' representatives of modern philosophy. Therefore it is in a way surprising that these two features should be rehabilitated by Kant, who ascribed them to the two paradigmatic examples of 'science' he considers in the *Critique of Pure Reason* (and in the other works of his 'critical' period). These examples are mathematics and physics (this last being in effect Newtonian mathematical physics). Therefore he made a gigantic effort to explain how such a conquest could be attained by these sciences, and inscribed this effort in the 'epistemological dualism' he fully and explicitly accepted. Indeed, he distinguished 'phenomena' from 'things in themselves', and declared phenomena to be 'pure appearances'. In spite of this, phenomena are knowable, while things in themselves are not; and they are knowable because they are based on sensible intuitions (the 'sensible impressions') that are passively received by our sensible capabilities (be they those of the 'external' or of the 'internal' sense). The intellect, on the contrary, is not endowed with intuition: it is active, but its activity reduces to the capability of 'unifying' the content of sensible

intuitions according to its own structural characteristics. Those characteristics are the 'pure concepts' or 'categories' that are no longer interpreted as the universal ontological features of being that the intellect abstracts from reality by means of its peculiar intuition, but simply as universal characteristics of human knowledge, unavoidably present in all knowledge since they are the very 'conditions of possibility' (or transcendental conditions) of knowledge as such. In such a way universality and necessity were recovered for any authentic knowledge, since they simply expressed the fact that unavoidably, and in all cases, we cannot know without using our intellectual a priori forms of knowing. The objects of knowledge are therefore 'constructed' by our intellect, but they are not 'produced' by it. Indeed Kant carefully distinguishes 'thinking' from 'knowing': thinking amounts to a pure combination of concepts, while knowing requires that these concepts be applied to actually present sensible intuitions. This is why Kant is concerned to distinguish his position from 'idealism' (that meanwhile had become the opposite of 'realism', as explained above). He qualifies his doctrine at the same time as 'empirical realism' and 'transcendental idealism'. The sense of this distinction resides in the issue of the 'dependence': realists maintained that the existence of the objects of our knowledge does not depend on our act of knowing them, idealists maintained that it does. According to Kant, the existence of these objects does not entirely depend on our act of knowledge, since the 'empirical' base is represented by sense intuitions that we do not produce, but are 'passively' received by us, while the construction of the objects follows the conditions imposed by our categories, and therefore depends on our intellectual a priori knowing capabilities.

These Kantian conceptions are so well known that we may dispense with illustrating them by means of quotations from his works. We want only to draw two conclusions from what we have said. First: while modern natural science has remained 'realist' in the ontological and epistemological sense (scientists admit that physical reality has an existence in itself, independent of our investigation, and that it is endowed with certain real characteristics, that are 'manifest' and can be known by us as they are), Kant gave a 'non-realist' interpretation of this science (what science knows is not reality in itself, or ontological features of reality, but a world of objects that are the organization of 'pure appearances' according to the transcendental conditions of our intellect). In spite of this he claimed to be, at least partially, a realist, in the sense that not everything in the objects of our knowledge 'depends' on us, because the sensible 'appearances' are only passively received by us. We find here a very

peculiar form of epistemological realism, that undoubtedly prefigures Putnam's 'internal realism' (and Putnam himself duly recognizes this fact). We must also underline, however, that Kant's solution strictly depends on his unquestioning adherence to the 'epistemological dualism', which postulates the unknowability of things in themselves, and reduces the whole of knowledge to something 'internal' to the subject. This weak point was challenged by Kant's followers (already Jakobi had noted that 'without the thing in itself one cannot enter criticism [that is, Kant's 'critical' philosophy], but with the thing in itself one cannot remain in it'), and German 'transcendental idealism' has tried to eliminate this discrepancy between reality and thought. What remains to be seen is whether an 'internal realism' can be advocated without falling into epistemological dualism, a question that we will take up later.

For the moment we can note that Kant's 'phenomenalist' interpretation of science did not immediately achieve a large consensus. On the one hand, transcendental idealism, having eliminated phenomenalism altogether, considered natural science as a correct but still inadequate form of knowledge, that must be surpassed by a philosophical understanding of reality (the romantic 'Philosophy of Nature' that developed within the idealistic framework in practice amounted to a devaluation of science). On the other hand, the rich harvest of technological applications made possible by the rapidly increasing advances of the natural sciences easily convinced the general public that science is indeed an adequate knowledge of nature, and positivism gave to this spontaneous conviction a philosophical consecration, declaring science to be the unique form of adequate knowledge, and discrediting philosophy's rival pretension. This position obviously expressed a realist view of science.

This realist view began to enter a period of crisis in the second half of the nineteenth century. The construction of non-Euclidean geometries gradually discredited the role of mathematical intuition, showing that logically consistent geometrical theories can be constructed starting from intuitively mutually incompatible postulates. Even when set theory seemed to provide the bedrock foundation for the whole of mathematics, the discovery of the antinomies in this theory destroyed the confidence that we can intuitively know even such basic 'entities' as sets. As a consequence, mathematics came to be seen as a great family of logically interconnected hypothetico-deductive systems expressed in a formalized axiomatic way, whose legitimacy was not due to their capacity to describe the properties of 'mathematical objects', but simply to their internal logical consistency, or non-contradiction.

As to physics, the realist view of Newtonian mechanics was strongly reinforced during the first half of the nineteenth century. This was not only because of the impressive mathematical developments of Newtonian mechanics, but also because of the gradual appearance of a 'mathematical physics' that, concretely speaking, was nothing but an attempt to express, interpret, and explain the phenomena studied in the different branches of physics by means of the concepts, mathematical tools, and models provided by mechanics. The simultaneous formulation by different scientists of the principle of conservation of energy in 1847 seemed to offer a deep justification for the 'mechanistic world-view' that was advocated, for instance, by such scientifically outstanding and philosophically sensitive scholars as Helmholtz and Maxwell (since this energy was thought to be transformable, in the last analysis, into mechanical energy). Therefore the challenge for theoretical physics was seen to be to elaborate adequate 'mechanical models' for the two new branches of physics, that is, electromagnetism and thermodynamics.⁴ This challenge, however, was doomed to failure, for no satisfactory mechanical model could be elaborated for the electromagnetic 'ether', and no satisfactory explanation of the second principle of thermodynamics could be provided within the framework of the kinetic theory of matter (in spite of the very ingenious efforts of several outstanding mathematical physicists on both problems). The reasons for these shortcomings soon appeared to be related to the fact that physics was seriously making its first steps into the realm of the unobservable. In this enterprise it made use of powerful idealizations, that were tacitly justified by two fundamental presuppositions, that is, that the laws and principles of mechanics have a true universality, and that their scope includes the microscopic as well as the macroscopic world.

Both these presuppositions were attacked by Ernst Mach, when he gave his diagnosis and therapy for this crisis of physics. His fundamental philosophical thesis was a form of radical empiricism, according to which only sense perceptions constitute knowledge. He did not deny a certain function to intellect. But he restricted it to the elaboration of general schemes that have no cognitive import, but only a pragmatic role, in the sense that they allow us to summarize sets of similar perceptions, to make useful predictions of future perceptual situations, and also to realize concrete applications. Intellectual constructions are simply conventions that can be abandoned and replaced whenever other conventions appear to be more useful. He added to this epistemological doctrine an ontological claim: unobservables are not simply unknowable, but also non-existent (indeed, he denied the existence of molecules). Therefore we must say that

he expressed a clearly anti-realist view of science that was embedded in a more general philosophical anti-realism (since pure perceptions are not sufficient even for affirming the existence and knowability of common-sense realities such as cats, plants, or stones). More interesting is his criticism of the universality of mechanics, that had led to the fruitless efforts of constructing mechanical explanations of electromagnetic and thermodynamic phenomena. He pointed out that mechanics enjoyed the historical privilege of being the first exact natural science, which explains why scientists were spontaneously inclined to apply its concepts and principles in the study of newly discovered phenomena. Such chronological priority, however, cannot be taken as equivalent to any ontological, conceptual or logical primacy: therefore there is no justification for claiming that mechanics ought to provide the framework for interpreting the totality of physical phenomena. It must be noted that all the described events occurred long before the creation of relativity theory and quantum theory.⁵ They only contributed to the deepening of the 'crisis' of classical mechanics, since they showed that many more concepts, laws, principles, and methodological presuppositions of this theory had to be fundamentally modified in order to satisfy the theoretical needs of the new physics.

Scientific realism (and anti-realism)

The rather lengthy story we have sketched above was necessary in order to propose a reasonable distinction between realism and anti-realism in general, on the one hand, and specifically scientific realism and anti-realism on the other hand. Indeed in many current discussions of realism and anti-realism that allegedly pertain to science, we simply find more or less elaborate variants of the positions about realism in general.⁶ The problem of distinguishing general realism from scientific realism, however, is not simple. But we are simply interested, here, in understanding how it happened that a realist view of natural science could be generally held for a long while, and be almost suddenly abandoned towards the end of the nineteenth century. The reason why classical mechanics could receive a realist interpretation is that it remained in keeping with the spontaneous realism of common sense, to the extent that it appeared as a kind of 'prolongation' of common sense itself. Its concepts were certainly abstract, but at the same time could be seen as 'idealizations' of concretely observable physical bodies or events: a material point could be seen as the limit image of a grain of sand, a

physical wave as the limit image of the waves in a pond of water, a rigid body as the limit image of an iron bar, a frictionless motion as the limit image of a perfect glass sphere moving on a perfectly horizontal ice surface, and so on. Though being concepts in a rigorous sense, they remained bound to observable physical objects or processes, they were visualizable (and this is why we have called them 'limit images'), and this spontaneously inclined people also to expect that other not explicitly encoded properties of the physical objects or processes from which the idealization had started should continue to be exemplified as well. Unfortunately this expectation was frustrated when models of the micro-world were put forth using the idealizations derived from the observed macro-world. The way out of this difficulty, in the spirit of classical physics, would have been to find new concepts obtained via idealization from the observation of the micro-objects, but they are unfortunately unobservable.

This is the frontier that separates contemporary physics from modern physics, since contemporary physics is essentially a physics of unobservable objects, and it is not by chance, as we have seen in our historical overview, that scientific realism began to be challenged when this frontier was encountered. Therefore we propose to characterize specifically the problem of scientific realism as the problem of the reality of the unobservables proposed by scientific theories. The suitability of this characterization is confirmed by the position defended by such influential scholars as van Fraassen: he accepts common-sense realism regarding the objects of everyday experience, since they are accessible to observation, and denies realism regarding the unobservable entities of natural science.

Can this position be defeated? A first step is to enlarge the concept of observation, based on the awareness that scientific observation is very different from pure sense perception, since it is essentially instrumental observation: we can say that we 'observe', for example, electrons through a suitable instrument like a Wilson chamber. This path is certainly fruitful, and scholars such as Shapere have developed it convincingly. The implicit assumption of this strategy, however, might be that observation (however enlarged) remains necessary condition for scientific realism. We maintain, instead, that it is a sufficient but not necessary condition, and that access to the reality of unobservables can also be obtained by means of the use of the intellect.

Realism and truth

At the beginning of this essay we noted that the problem of realism must not be mixed up with the problem of truth, since it is 'primarily' an ontological problem. This does not mean, however, that the ontological, the epistemological, and the semantical aspects of this problem, though distinct, should be separated. On the contrary, we shall see now that the reality of unobservables (ontological question) cannot be affirmed without resorting to truth and logic. Let us first remark that the notion of truth is intrinsically realist, since a judgement (intellectual level) or statement (linguistic level) can be said to be true if and only if 'it says of what is the case, that it is the case, and of what is not the case, that it is not the case'. This Aristotelian definition, that is already prefigured in Parmenides and almost literally formulated by Plato, not only corresponds to the common-sense conception of truth, but is implicitly or explicitly admitted by all philosophers in the whole history of Western philosophy. Differences (and notable differences) only regard the criteria of truth. Among such criteria intuition and logical consistency were soon identified as prominent. Intuition has been seen as the criterion for immediate truth, and logical consistency as the criterion for mediate or inferred truth. As to intuition, it was historically divided into sensible intuition and intellectual intuition (as we have already seen), and modern science predominantly emphasized sensible intuition or observation. As to inference, logic was created as the study of those intellectual (and linguistic) links among judgements that are truth-preserving, in the sense that if we apply them to true judgements (or statements) they necessarily lead to true judgements (or statements). This specific characteristic of logic is founded on the intentional identity of being and thought of which we have already spoken, and which can be summarized in the statement that thought cannot be thought of 'nothing', and therefore cannot help but being thought of being. This fact is reflected in the double formulation of the principle of non-contradiction: its logical formulation says that 'it is not possible to affirm and deny anything at the same time and under the same respect', and this because 'nothing can at the same time and under the same respect exist and not exist, or be such and such and not be such and such' (ontological formulation).

From these characteristics some consequences follow:

1. Whatever cannot be thought of (in the rigorous sense of being self-contradictory) cannot exist (logical contradiction entails ontological impossibility), and whatever can be thought of (in the sense of being

logically consistent) may exist (logical consistency entails ontological possibility).

2. If from an intuitively true judgement another judgement logically follows, the latter judgement is also true even when it is not intuitive.
3. Everything that exists must exist together with all things without which its existence would be contradictory.

This third statement is a sub-case of the second, once the ontological import of logic is accepted, since it says that the particular logical inference called *reductio ad absurdum* obliges us to admit the existence of even those unobservable realities without which features of the existing and observed realities would turn out to be contradictory. If we scrutinize the most rigorous arguments proposed by those metaphysicians who wanted to demonstrate the existence of meta-empirical entities, we can find that they more or less implicitly relied upon this statement.

Leibniz's principle of 'sufficient reason' ('everything existing must have sufficient reasons for its existence') constitutes an 'attenuation' of statement (3). He did not deny this statement (none who accepts the ontological import of logic can deny it), but admitted a flexibility in the determination of the conditions that make concrete reality intelligible (that is, non-contradictory). Therefore, in keeping with statement (3), he admitted that without the existence of God the existence of concrete things would be contradictory, but he thought that the logico-ontological dependence of the real world from God constitutes a chain that could have been different, since other chains could have provided a logically consistent set of 'sufficient reasons' for the existence of the world. The actual world does not result from logical necessity, but from free divine decision, and is therefore 'the best of all possible worlds', where 'the best' expresses the choice of divine wisdom that must not be confused with logical necessity. In this sense the world is contingent. It was Hegel who embarked on the ambitious enterprise of endowing the whole of reality with logical necessity (and in his case it may be right to say that he claimed to identify knowledge of reality with a 'God's Eye point of view').

What has all this to do with scientific realism? Scientific theories try to satisfy the Leibnizian principle of sufficient reason: indeed they try to offer, by introducing a certain number of unobservable entities endowed with precise properties, a global picture in which the observable objects of their domain can be logically explained, that is, can be shown to be logically connected with these entities in such a way that sufficient reasons for their observable features can be offered. But, one might say, how can

one be sure that the unobservable entities 'really exist', since any theory only provides sufficient reasons, and we all know that – all theories being 'underdetermined' with respect to observable data – several different theories could be proposed capable of providing sufficient reasons for the same data? In this question several aspects are unduly confused, and we shall try to disentangle them:

1. The underdetermination of theories is a strictly epistemological fact, that in the last analysis reduces to the well-known logical fact that the truth of the conclusion of a correct argument is not a sufficient condition for granting the truth of the premises. This 'granting' actually means that, in this particular case, logic does not provide a fully reliable tool for knowing whether the premises are true or not. But this does not at all affect the fact that the premises are in themselves, and necessarily, either true or false, since this is an intrinsic semantical property that is independent of any epistemological condition. For example, if the only observational evidence available to me is that my wallet is no longer in my pocket, I can formulate different hypotheses that can logically explain this fact: that I have left it in my office, in the restaurant, in the supermarket, that I lost it in the bus, and so on, and I do not know which of these different hypotheses is true. However it is obvious that at most one of them is true, and perhaps none (for example, my wallet has been stolen by a pickpocket). In conclusion: underdetermination of theories only entails the epistemic situation that we never attain absolute certainty about their truth.
2. The nature of truth, expressed in its semantic definition already mentioned, contains an ineliminable ontological component: a statement is true if and only if the 'state of affairs' it describes really exists. If I hold that the statement 'there is a copy of Kant's *Critique of Pure Reason* in the library of my department' is true, I must necessarily hold that this book really exists in this library, independently of the fact that I am seeing it at the moment of uttering my statement. Coming to scientific theories, we must say that if one holds that a certain theory is true, one cannot consistently avoid holding that the 'states of affairs' it describes really exist, independently of the fact that such states of affairs involve unobservable entities. As a consequence, the only correct way to deny the existence of the unobservables introduced in a scientific theory is to say that the theory is false. If we are in the position of holding (even without absolute certainty) that the theory is true 'beyond any reasonable doubt', we must also

hold 'beyond any reasonable doubt' that the unobservables it introduces really do exist.

Is it possible to escape these conclusions? Certainly it is, but at a very high cost. A first move can consist in denying that scientific theories can be qualified as either true or false. There is a grain of reasonableness in this position, since truth and falsity have been directly defined for single statements, and not for sets or systems of statements such as whole theories. There is, however, the possibility of 'broadening' this definition to include in an 'analogical' sense the notion of true and false theories. The ground for denying truth or falsity for theories, however, usually consists in a much less justifiable philosophical tenet: radical empiricism, which we have seen to play its devastating role already with Mach. This tenet is totally dogmatic, since it reduces the cognitive capability of humans to sense perception, contrary to common-sense evidence and also to the evolutionary interpretation of the characteristics of humankind. In fact, we (rightly) believe that we know that Caesar crossed the Rubicon, that he was killed in the Roman Senate, that Napoleon was defeated at Waterloo, and so on, without having any possible observational access to these past events, but simply because we confidently rely on such instruments of historical knowledge as documents, photographs, and records of facts, that induce us to hold 'beyond any reasonable doubt' that these individuals really existed, and that true stories are told about certain past events. Similarly we claim to know of the existence of numberless cities and regions of our planet we have never visited. In short, though this knowledge has originated in the 'observation' made by a few single individuals, it can become knowledge for many other individuals only thanks to a very complex cognitive role of human intellect (intersubjective knowledge is impossible within pure sense perception or observation). One might wonder why such total confidence is placed in observation. The most plausible answer is that direct observation is endowed with certainty. A slight acquaintance with the history of philosophy, however, abundantly shows serious criticisms of sense knowledge and, if the opponents of the reliability of the intellect can mention such stock examples as phlogiston, opponents of the reliability of observation can mention such equally stock examples as the stick that appears bent in water, or the earth that appears motionless at the centre of the universe. The real situation is that human knowledge is constituted by an interplay of both sense and reason, and that the cooperation of both enables man to attain truth about reality, in its observable and unobservable dimensions.

Objects and properties

A more subtle objection that can be raised against the existence of unobservable entities is that all that scientific theories can offer is the determination of certain properties of the world (usually expressed by mathematical relations and equations), but not of the objects that allegedly possess such properties. Therefore, while a certain realism of properties could be accepted, a realism of entities should be rejected (Poincaré, for example, already admitted a limited 'realism' of science in the sense that only the relations between the phenomena discovered by science are to be taken as real, not the objects that theories claim enter into such relations). In spite of seeming very modern, this issue is actually very old: in the vocabulary of classical ontology distinguishing 'substance' from 'accidents', medieval philosophers had already noted that, while a substance is not identical with its accidents, we can only know a substance through its accidents. A substance, as we know, is an individual entity existing in itself, while accidents are the qualities and relations that can only exist in a substance and not in themselves. If we actually know an individual substance – for example, a given dog – even at the level of pure observation, what we know are several accidents (in this case, sensible qualities), but certainly not all of its qualities (for example, its being the most cherished living thing of an old lady): nevertheless we rightly say that we know this dog, since these qualities are 'its' qualities. In other words, to know an individual amounts to knowing 'what it is like', and this means knowing certain features of it that are, so to speak, intrinsic and stable, such that they enable us to identify it, and also to re-identify it in different conditions. As Strawson⁷ has rightly pointed out, in order to identify an individual object we need to use a 'sortal', that is, a term indicating 'what sort of object it is', and this sortal unavoidably contains in its meaning an organized system of properties that are concretely realized in the individual. Even theologians, when they try to characterize the particular individual entity that is God, cannot help but doing so by means of certain properties (such as omniscience, omnipotence, eternity, immutability, creative power, and so on). In conclusion, since accidents (or qualities) cannot exist in themselves, but are always qualities of something, it is impossible to maintain that we can know qualities that are qualities of nothing: we know something through its qualities.⁸

If all that we have said is true of knowledge in general, it must be true also of science in particular. We can easily verify this by reconsidering the breakthrough which constituted the core of the 'Galilean revolution'. A realizable knowledge of the 'natural substances' must renounce the

pretension of grasping their intimate essence, and be content with knowing some of their 'affections' or 'accidents'. Therefore, natural science was considered to be a knowledge of natural substances, attained through the knowledge of a selected set of their accidents. This methodological approach has become characteristic of every empirical science in the modern sense of the concept. Leaving aside the nowadays old-fashioned terminology of 'substance', 'accidents', 'affections' and the like, we shall say that every empirical science presents itself as knowledge of reality, not in general, but from a specific 'point of view', that amounts to considering only a selected set of attributes of things. This set of attributes delimits the domain of objects of the given science, in the sense that only those things that are endowed with all these attributes can become the 'object of study' of the said science. Mechanics, for example, selects as attributes of things with which it will be concerned only mass, location in space, location in time, and force. Therefore, on the one hand, concretely existing and perceivable things such as a toothache, or a symphony, cannot be objects of mechanics because they fail to possess at least one of mechanics' specific attributes (for example, mass). On the other hand, one single thing may become the object of several different sciences, according to the different points of view from which it is investigated. A cat, for example, is an object of mechanics when we try to explain how it can fall from a window and yet reach the ground on its four paws without infringing any law or principle of the mechanics of falling bodies, but it is an object of chemistry if we study the composition of its hair, an object of animal psychology when we study how certain conditioned reflexes come about in its behaviour, an object of economics when we want to explain why it is sold at a very high price on the market, and so on.

Any mature science determines its domain of objects when it is able to characterize its selected attributes by means of clearly defined concepts that are also mutually correlated. These concepts are linguistically expressed using certain predicates that make up the 'technical vocabulary' of a given science, and their correlations (that also amount to a 'contextual definition' of their specific technical meaning) are expressed in certain fundamental statements, often called laws or principles. In the case of physics these predicates are magnitudes and these statements are mathematical expressions (in the majority of the cases, equations or 'disequations'), but this additional condition is not required for other sciences. To sum up: every (empirical) science is concerned with certain attributes of things (ontological level), that are abstracted and idealized in certain concepts (intellectual level), and expressed by means of certain predicates (linguistic level). Since every science aims at knowing reality,

though only from its specific point of view, it must equip itself with certain tools of reference that enable the scientist to ascertain whether or not a given 'thing' really possesses a certain attribute in the way described by a statement of his science. Owing to the fact that scientific knowledge seeks to be intersubjective, such tools are provided by standardized operational procedures that are neither linguistic nor mental, but are as much concrete as things, and which enable one to know whether a proposed statement is immediately true of that thing, or not. This entails that at least certain predicates of an empirical science must be also operationally defined, in the sense that they are related to certain precise operational procedures of referentiality. It is thanks to these procedures that a scientific concrete object can be 'cut out' of a concrete thing. We will call such operationally defined predicates 'basic predicates', and say that they permit us to construct scientific objects, not in the sense of creating them, but in the sense of determining them as particular aspects of reality. For example, the predicate 'mass' of classical mechanics is equipped with the operational procedure of putting things on a balance in order to check the truth of the statement that a certain thing has a mass of x grams (within the limits of precision of the balance employed). The states of affairs resulting from such operational procedures are the data of a particular science, that correspond to the immediately true statements it must accept according to its own constitutive conditions.

The discourse developed thus far holds for every empirical science, but natural sciences are characterized by the fact that they do not study single entities or processes, but general properties of indefinitely large classes of things and processes, and this entails that the actual contents of their investigation are those ideal objects that result from the combination of the specific concepts and conceptual correlations we have mentioned above. To make things easier we will bracket for a moment the mental level and consider directly the linguistic level. From this point of view, a scientific object becomes a structured set of predicates, and all objects that are introduced by a scientific theory are of this kind. We must therefore say that scientific objects (in this new sense) are abstract objects, such as the previously considered examples of material point, rigid body, elastic recoil, frictionless motion, perfect gas, and so on. We must now remember that any abstract object (that is, any well-defined concept) is totally and adequately characterized by the finite collection of properties it encodes. In this sense it is not appropriate to say that it has its properties, but that it *is* its properties. If we want to call it an 'entity' (and this is not arbitrary since it has a mental existence, can be identified, and receive a proper name), we

can say that knowing the properties amounts to knowing the entity in the full sense, that is, without any residue.

We must not forget, however, that the purpose of natural science is to know nature, and this entails that at least some of the abstract concepts of a natural science must also be exemplified by concrete things. This condition is fulfilled by the fact that, thanks to the operational tools, at least some logical consequences derived from the admission of abstract entities must be exemplified by experimental tests, that is, recognized as immediately true. Since, however, we have already seen that the truth of the consequences may also lead us to admit (even without absolute certainty) the truth of the premisses, we can say that, if such a truth is established beyond any reasonable doubt, we must also admit that the abstract entities are exemplified, that is, that they have their (unobservable) referents, that they are not pure concepts or linguistic constructions. In other words, there exist electrons and elementary particles, and not only the concepts of 'electron' and 'elementary particle'.

Let us come to a final and important point. In the above reflections we have stressed that the admission of unobservable entities is legitimate when it allows for a correct account (and, we must add here, also for successful predictions) of operationally testable events. Such an 'account' is usually interpreted as a logical justification, but this is only a consequence of the 'statement view of theories' that is in turn a consequence of the 'linguistic turn' that has also affected in particular the philosophy of science. One must recognize, however, that all this is simply a logico-linguistic translation of something which, for common sense and also for scientists, is a causal explanation. The occurring of certain concrete states of affairs cannot be seriously conceived as being produced by conceptual or logical operations. Concepts and statements can only 'produce' concepts and statements by means of intellectual operations, they cannot produce concrete things or events. From this point of view, the affirmation that, outside a realist conception of science, the widespread success of scientific predictions would be a miracle is far from being so trivial as certain philosophers of science maintain. On the contrary, the constant and even overwhelming development of technology is a gigantic confirmation of the realist import of the scientific theories that technology applies, since it does not apply them to conceptual debates, but to the real world.

Realism and perspectivism

What we have presented allows us to see that realism is fully compatible with perspectivism, since the fact that we consider reality simply from a certain point of view (or 'perspective') does not eliminate the fact that, in such a way, we are considering or singling out certain real aspects of reality, aspects that 'belong' to it, even if they could be uncovered only by resorting to a particular perspective. For example, conic sections are 'really' contained in a cone, though we can bring them to light only by 'cutting' the cone by means of a suitably oriented plane. If the plane is parallel to the base we obtain a circle, while we obtain an ellipse or a hyperbola if the plane has a different inclination. These geometrical figures can be obtained by cutting an ideal geometric cone by means of an ideal geometric plane, but if we cut a material cone by means of a materially realized plane, we can actually observe geometrical shapes that exemplify the conic sections. That they are 'real attributes' of the cone immediately results from the fact that we cannot obtain them by 'cutting', let us say, a pyramid or a cube. Moreover, these figures may be described and treated in several ways and according to several languages: for example, we find in the textbooks a 'projective theory of conic sections', as well as an 'analytic theory of conic sections', in which their properties are described and investigated from the 'point of view', or 'within the perspective' of projective geometry or analytic geometry respectively. The broadening of the mathematical investigation can lead to the creation of specialized technical expressions that are only indirectly reminiscent of the original situation, for instance when we speak of 'elliptical equations' in analysis, or of 'elliptical geometry' for characterizing a particular kind of non-Euclidean geometry. At the same time, other concrete objects may be found that exemplify the concepts of these conic sections, like the planetary orbits, that turned out to be elliptical, and not circular, as they had been believed to be at first.

This discourse is true in general: every property of a thing really exists in the thing, on the one hand, but can be known only within a suitable perspective. For example, if I observe a rose under 'normal' sunlight conditions and I find that it is red, while the grass around it is green, I must say that the property red is real in the rose, and the property green is real in the grass, since I cannot help but see them this way, and I cannot see the rose as green and the grass as red. All this, however, does not simply depend on the intrinsic properties of the rose and the grass, but also on suitable lighting conditions and on the specific constitution of my visual apparatus. If the rose or the grass are observed under some peculiar

artificial light, or by an eye affected by certain disturbances (for example, by colour-blindness), the perceptual colour of these same objects will really be different. It is only for the needs of intersubjective communication that we say that the real colour of concrete material objects is that which is perceived by a 'normal' eye under 'normal' light conditions. If we 'observe' the rose or the grass by means of a standardized physical apparatus, such as a photoelectric cell, we might believe that we have access to their 'real' colour. But this is a misunderstanding: such an apparatus will tell us that electromagnetic waves of a certain predominant wavelength have been emitted by the surface of these physical bodies. But this is by no means a 'perceptual colour', since it can only be thought of from this point of view, and even a blind person can say that the rose is red, without any possibility of perceiving it as red. This possibility of thinking and saying is based only on the translation of the perceptual vocabulary into a physical-theoretical vocabulary made possible by those who have 'linked' the 'normal' perceptual red with the 'standardized' physical red, for they had direct access to both of them.

Since, as we have seen, realism is fully compatible with perspectivism, we can conclude that realism does not imply a 'God's Eye point of view'. If we think of God as omniscient, we may say that he is able to know reality from all possible points of view, and not from no point of view, or from nowhere, since his infinite cognitive capability allows him to know all aspects of reality from an adequate point of view. Human knowledge is finite, and therefore we can only know attributes of reality that are accessible to man from a limited number of points of view: those that are constituted by his sense organs, and by his intellectual power (which, in particular, enables him to construct instruments for broadening the possibilities of his 'observation'). We can also express these conclusions by saying that genuine knowledge need not be total knowledge (this might be the privilege of divine knowledge), and also that truth (specifically considered as a property of judgements, statements, theories, that is, of ways of expressing knowledge) is always relative, that is, on the one hand, relative to the referents of the discourse and, on the other hand, relative to the cognitive tools adopted. Absolute truth (in the sense of being independent both of referents and of cognitive capabilities) is not a privilege even of God.

External and internal realism

Our reflections enable us to maintain that realism (including scientific realism) must be considered at the same time (but under different respects) as 'external' and 'internal'. These adjectives are rather pictorial, and have a topographical shade of meaning that must be clarified in a conceptual way. This is not easy to determine, and the same Putnam who insisted on this distinction, was actually able only to mention a list of features that should characterize these two philosophical perspectives, without really 'defining' them. We can venture, however, to give a rather precise characterization by taking knowledge as reference point, and calling 'external' that form of realism that maintains two theses:

1. That reality consists of ontologically existing things with all the attributes that characterize each of them, and this existence does not depend on our knowledge of them (that is, this knowledge is not a condition for their existence).
2. This reality is the content of our knowledge, in the sense that we could not call knowledge in a proper sense any mental or linguistic construction whose referents would not be really existing entities or properties.

By way of opposition we can call 'internal' that form of realism that maintains:

1. That reality depends on knowledge in the sense that – as Putnam says – "objects" do not exist independently of conceptual schemes'.⁹
2. That referents of our knowledge are objects that are constructed by our cognitive capabilities themselves.

There is a sense according to which internalism is irrefutable, but this is a very trivial sense: reality of which we can speak, affirm the existence, know properties, and so on, is strictly reality that is included within our knowledge. In fact, it is obvious that 'speaking of', 'affirming', and so on are ways of expressing our knowledge. Therefore, claiming that we cannot know reality 'outside' knowledge, or 'independently of' knowledge is an epistemological truism. Indeed, not even the most radical 'external' realist would deny that things and properties, though existing independently of any knowledge (ontological level) cannot be known, and their reality cannot be affirmed, outside knowledge. Therefore the correct position

seems to be expressible in this intentionally pictorial way: things exist 'outside' the mind (or outside theories), but can be known only when they are 'internalized' within the mind (or within theories). Therefore, Putnam is right to say that '*what objects does the world consist of?*' is a question that it only makes sense to ask *within* a theory or description',¹⁰ and this is simply because in order to answer this question we must know how the world is, and this knowledge is necessarily expressed in a theory or description. However, we can maintain that this question is answered correctly only if we are convinced that the description says how the world really is.

Is there a possibility of satisfying this requirement within an internalist perspective? There is one, which consists in maintaining that things are nothing but intellectual constructions. But this move would reduce internal realism to idealism, something Putnam does not want. For this reason he explicitly subscribes to Kant's solution, admitting that 'there are experiential inputs to knowledge; knowledge is not a story with no constraints except *internal* coherence, but [internalism] does deny that there are any inputs *which are not themselves to some extent shaped by our concepts*'.¹¹ These inputs, as stated a few lines above, are 'the "objective" factor in experience, the factor independent of our will'. In conclusion, the nail on which 'realism' is hung is the 'passivity of sensation' already claimed by Kant and, exactly as in Kant, depends on the dogmatically presupposed epistemological dualism we have already discussed above.

The position we are advocating, and which we preferred to call 'metaphysical realism' in the richer sense already explained, simultaneously affirms the ontological existence of things and properties, that are open to knowledge since they are in part sensible and in part intelligible. The suffix '-ble' usually indicates a potentiality (as in *thinkable*, *feasible*, *practicable*, *preferable*, and so on), and in our case indicates that certain properties can give rise to sensations or concepts if they 'stimulate', so to speak, either certain well-determined sense capabilities or else our intellect. This stimulation, however, must not be confused with a purely physical action (therefore, the criticism developed by Putnam and other authors against a 'causal' theory of sensation or perception, as well as of the 'similarity' theory of the same, is well grounded). This stimulation is actually a simple 'intentional presence', that 'internalizes' the sensible and intelligible properties not in an ontological sense (they remain properties of things, and do not become properties of the eye or of the mind), but so as to permit the actualization of the cognitive capabilities of sense and intellect. These cognitive capabilities are in part inborn, and in part modified by the accumulation of past

knowledge and by several cultural factors, so that the 'conceptual schemes' of which Putnam speaks are certainly part of this interplay between reality and mind, but they simply help men see reality from certain points of view or perspectives, that can often lead to the discovery of previously unknown attributes of reality, but are not automatically granted to 'match' ontologically existing properties of reality. It is certainly significant that Putnam, and many other scholars discussing the issue of realism, do not even mention this fundamental notion of intentionality.

Another notion that is inadequately discussed by the same authors is that of 'reference', and this is not surprising for reference is intimately connected with intentionality. Referents are those entities that do not belong to the same ontological level as the discourse that is about them, and for this reason they must be attained by other means than pure thinking or pure speaking. We have already explained that every empirical science must equip itself with operational tools of reference, and this already stresses that it is through a certain 'doing' that we try to meet the referents, a doing that is certainly 'guided' by meaning and theoretical constructions, but whose outcome is by no means predictable or predetermined by any theoretical or linguistic manoeuvre. Precisely these criteria of reference determine the ontological status of the entities about which a theoretical discourse tells its story. A referent is an entity that exemplifies a concept or a theoretical construction: such concepts or constructions, as we have seen, constitute the abstract objects of a theory or description and as such have a purely mental existence, but the referents or concrete objects of the theory or description must be detected by extratheoretical means. For example, not only must the concept of a rigid body be exemplified (within an acceptable approximation), by certain material bodies, but also the affirmation that Hector is a Trojan warrior in the *Iliad* can be said to be true only if, by a particular operation (reading the *Iliad*) we find that this 'literary entity' really possesses (in the *Iliad*) the property of being a Trojan warrior.¹² Of course, the 'linguistic turn' that has in particular led to an almost complete 'contextualization' of meaning, has almost fatally produced a conflation of meaning and reference. This, however, is a shortcoming of this philosophical approach. It must be overcome if we want to discuss the issue of realism in all its complexity, and, in particular, recover the autonomous sense of referentiality. This means that, as Putnam says, we must give up the 'similitude theory of reference' (which, by the way, was not advocated by classical epistemology), but not in order to accept a contextual theory of reference, that is equally unsatisfactory. What we propose is an operational theory of reference that enables our

discourses to be about a reality that is not produced by the discourse, but only intentionally present to it when it is concretely met through concrete operations.

Notes

- 1 Putnam (1981, p. 49).
- 2 For a detailed discussion of Galileo's position, see Agazzi (1994), which provides the necessary quotations from his writings, that were published in Galileo's *Opere*.
- 3 These general methodological principles are clearly summarized, for instance, in the *Scholium Generale* of Newton's *Principia* (Newton 1687) and, in a more elaborated form, in Question 31 of Book 3 of his *Opticks* (Newton 1704).
- 4 For example, even J. C. Maxwell, in the last pages of his *Treatise on Electricity and Magnetism*, indicated as a task for future generations that of finding a mechanical description of the electromagnetic field for which he had offered his famous equations. For details on this issue see, for example, my large introduction to my Italian translation of Maxwell's work (Maxwell 1972), as well as Agazzi (1975).
- 5 Mach's work on the historical development of mechanics, which substantiates his views on this issue, was actually published in 1883 (cf. Mach 1883).
- 6 This is the case, for example, even with a famous philosopher of science such as Popper.
- 7 Strawson (1959).
- 8 Classical epistemology was perfectly aware of this fact, expressed in a very eloquent principle: *alia sunt subiecta qualia permittuntur a predicatis suis* (subjects are such as they are permitted to be by their predicates), which means, ontologically, that entities are such as their properties allow them to be. In other words, properties are 'constitutive' of entities.
- 9 Putnam, op. cit., p. 52.
- 10 Op. cit., p. 49.
- 11 Op. cit., p. 54.
- 12 For a detailed discussion of this issue see Agazzi (1997).

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