A MORE RADICAL CRITIQUE OF MATERIALISM[1]

A DIALOGUE WITH BAS VAN FRAASSEN ABOUT MATTER, EMPIRICISM AND TRANSCENDENTALISM

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Introduction

In his book *The Empirical Stance*, Bas Van Fraassen develops a strong and subtle attack against materialism. My aim in this paper will be to amplify this criticism from a mainly neo-Kantian standpoint, and to identify by contrast some reasons why Van Fraassen tends to balk at the ultimate consequences of his contest. The structure of the paper is as follows. In section 1, I review Van Fraassen's construal of materialism as a *stance*, and examine some motives many thinkers have to resist this idea. In section 2, I describe the drifting conceptions of "matter" according to materialists, and state two motives I have to be less indulgent than Van Fraassen for the particulate conception of matter. In section 3, I document the first motive : loss of the basic cognitive conditions that would enable the particulate conception of matter to provide us with a coherent and unified representation. In section 4, I examine a general criterion of materiality, beyond the circular statement that matter is composed of material particles : matter must be both objective and able to manifest itself in space-time. In section 5, I apply this criterion and find difficulties on both sides of the Cartesian divide. It then appears that materialism is bound to be methodologically conservative. In section 6, I state a meta-value (progressiveness, open-mindedness) that is shared by materialists to a certain extent, but show that both empiricism and neo-Kantianism fare better with respect to this meta-value. This is the second motive I have to be more assertive against materialism than Van Fraassen is. Finally, in the conclusive section 7, I try to display some limitations in Van Fraassen's position that prevent him from offering a far enough reaching critique of materialism. Transgressing these limitations would require to adopt a modern version of transcendental epistemology in the style of Ernst Cassirer. Indeed, while the latter epistemology

[1] Part of the material of this paper was presented at the workshop about Bas Van Fraassen's Thought I organized in june 2003 in Paris. Other parts were developed at the Università Gregoriana in Rome. I thank the audiences of these events, and especially Bas Van Fraassen himself. I also thank an anonymous referee for his sympathetic criticism. The paper was originally published in *Images of Empiricism, Essays on Science and Stances, with a Reply from Bas van Fraassen,* Edited by Bradley Monton, Oxford University Press, 2007, with the title : "MATERIALISM, STANCES, AND OPEN-MINDEDNESS"

shares many presuppositions with constructive empiricism, it generalizes mere model-dependence of laws into full-blown "constitution of objectivity".

1-Thesis or Stance : The Status of Materialism

In *The Empirical Stance*[2], Bas Van Fraassen points out : (a) that materialists have a wrong idea of the status of their own position, and (b) that this wrong idea is nevertheless in agreement with their construal of what *is* or should be a position. Materialists believe that materialism is tantamount to a certain *thesis,* namely the thesis that *all there is is matter*. This belief is likely to be both a consequence of and a support for another belief : that philosophical positions consist in holding a definite thesis[3], and that scientific theories in turn imply a certain thesis about what the world is like. However, when they try to clarify this strong proposition, materialists are caught into the ontological ambivalence and historical sensitivity of scientific concepts, including the concept of matter itself. Therefore, as Van Fraassen aptly remarks, materialism can only be construed as a cluster of *attitudes, or stances,* underpinning a potentially endless research program. Interestingly, by showing that this characterization does more justice to materialism than its own self-understanding, Van Fraassen simultaneously strengthens his empiricist construal of philosophical positions as open-ended stances. One position (empiricism) is given precedence over another position (materialism) by way of its superior meta-account of what "position" means.

But what is a " stance ", in this half-philosophical and half-existential sense? It is primarily a way of behaving; an interpretative orientation; a commitment to act and understand events along with a certain outlook. At the most superficial level, a stance is tantamount to an "epistemic policy" to be adopted in the definition of what counts as facts. There can be an empiricist policy, which imposes severe restrictions on what is to be treated as factual ; a realist policy (see Rom Harré's "policy realism"[4]) which is liberal enough with the factual status of the formal entities of physics ; and a materialist policy which shares several features with the realist policy but which (as we shall see) maintains historical constraints on factual propositions. At a deeper level, a stance partakes of Wittgenstein's *form of life*, to wit a way of doing, speaking and seeing that is not formulated as such but pre-conditions any formulation.

The value of a stance then does not reduce to the possible truth of the thesis which is allegedly associated to it; its value rather consists of its ability to endow research with a definite direction, and to clarify other philosophical positions by

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[2] B. Van Fraassen, *The Empirical Stance,* Yale University Press, 2002

[3] Materialists are not necessarily committed to the belief that *any* kind of philosophical position is a thesis. Nothing prevents them from making exceptions for (say) Ethical and Aesthetical positions. I owe this remark (and so many other thoughts) to recent discussions with Bas Van Fraassen.

[4] R. Harré, *Varieties of Realism,* Basil Blackwell, 1986

contrast with it. This status of philosophical positions (stances rather than statements) may explain why many of them are unable to carry widespread conviction, and why they are usually blind about the reasons of this unability. A thesis can in principle be proved or strongly argued, whereas a stance can only be adopted by a " Gestalt-switch " : "Being or becoming an empiricist will then be similar of analogous to conversion to a cause, a religion, an ideology (…)"[5]. This characteristic of stances is currently considered as a real difficulty of Van Fraassen's position, which should be addressed unless it falls prey to relativism[6]. Until now, Van Fraassen himself has left this question partly open. But I think his ideas can easily be amplified so as to make convincing answers to the former objection available.

Let me first remind that N. Goodman was also strongly criticized for similar reasons. In reply to some of his opponents, Goodman then went as far as emphasizing that it is sometimes legitimate to state a philosophical idea without any argument. Why is it so? Because very often, he declared, a philosophical idea is not itself a belief or a thesis. It is, rather, a "categorization, or scheme of organization"[7] which conditions in advance any future belief or thesis, and which also sets the frame for actions and attitudes. This idea is averse to the dominant practices of analytical philosophy, but it is tacitly accepted in continental philosophy. Stating it explicitly, as Goodman and Van Fraassen do, could then be a useful step to promote dialogue between the two philosophical traditions.

Besides, one must realize that, in the process of promoting a certain stance, arguments may *also* be used. But admittedly, in this case, they have no other value than performative. They are "perlocutionary" in Austin's sense, in so far as their priority is to bring about a specific effect on their audience (if this audience is disposed to comply). These arguments can even claim truth, which represents a strong pragmatic constraint on the audience ; but it is accepted that this constraint is only partial, and that arguments are *not* ultimately compelling : claiming truth does not mean detaining truth. Many other performative strategies are therefore adopted jointly, in order to favor the gestalt-switch. One of them is to immerse the audience in the midst of a new system of background presuppositions, by taking it for granted from the outset, and by speaking and behaving as if it were already enforced. Conviction arises from seeing the coherence and internal harmony of the new position within which one has been immersed, as well as its possible agreement with one's former or present *form of life*.

Let us suppose at this point that, despite this *factual* variety of the ways of promoting philosophical positions, someone still wants to stand up for the view

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[5] B. Van Fraassen, *The Empirical Stance*, op. cit. p. 61

[6] A. Chakravartty, "Stance relativism: empiricism versus metaphysics", *Stud. Hist. Phil. Sci., Part A, Volume 35, 173-184*, 2004

[7] N. Goodman, *Ways of worldmaking*, Hackett Publishing Company, p. 129

that philosophical positions are theses rather than attitudes. That could perhaps be justified by a *deontological* principle which can be formulated thus: " It is our *duty* to treat philosophical positions as theses, because this is tantamount to accept that arguments for or against them are compelling, and because accepting that is an indispensible presupposition of debate ". This deontological view of positions as theses is not just fancied. It is made likely by the content of the controversy about *The Empirical Stance*. After all, Van Fraassen's factual statement, according to which philosophical controversies are *in practice* never solved, and reason alone is not in practice sufficient to select a philosophical position about science, is not challenged by its opponents with another conflicting factual statement. Rather, it is challenged with a generally implicit normative statement according to which philosophical positions *should* be discussed *as if* the arguments could eventually become compelling.

My objection to this deontological prescription is that, usually, it remains implicit. It is not formulated as such, but rather as an unshakable *belief* in the accessibility of philosophical positions to rational decision. But this shift from prescription to belief is one more dogmatic step, after metaphysics itself. It only reduplicates the belief in philosophical statements with the belief in a second-level statement (the statement that philosophical statements are rationally decidable), whose warrant is just as weak as that of the first-level statements. Therefore, prescribing to submit each position to discussion is *also* tantamount to adopt a certain stance; but this time a *meta*-stance that is accepted by a vast majority of philosophers for the obvious reason that it defines philosophy as a disciplin.

Clearly, the absolute conviction that there exist *ultimate* arguments involves something more than a thesis. Claiming that philosophical positions *are* theses, itself characterizes a particular *stance*. Therefore, the 'thesis' thesis is somehow self-defeating. This remark could easily be used by Van Fraassen to turn back his opponents' attack against them.

Before I turn to a fuller characterization of the materialist stance in the subsequent sections, let me try to locate it by comparing it with some other stances.

A diametrically opposite stance would be spiritualism, especially theological pan-spiritualism : something like Berkeley's "immaterialism" or Malebranche's "vision in God". According e.g. to Malebranche, "What (minds) see in God is very imperfect, whereas God is most perfect. They see matter that is shaped, divisible, and so on, but there is nothing divisible or shaped in God, for God is all being, since He is infinite and comprehends everything"[8]. Malebranche here ascribes our representation of matter to the narrowness of our

[8] N. Malebranche, *De la recherche de la vérité,* Livre III, IIème partie, chapitre VI, in Œuvres I, Gallimard-Pléiade, 1979, p. 339. Engl. trans. T. M. Lennon and P. J. Olscamp : N. Malebranche, *The Search after Truth*, Cambridge University Press, 1997, p. 231

ordinary standpoint, within an all-encompassing spiritual God *of which we partake*. From this local standpoint, we see « in God » a set of very local aspects of Him : shapes and boundaries. The fullness of God's nature, which is shapeless and limitless, would be fully revealed only in mystical contemplation.

Van Fraassen however tries to compare materialism with another stance which, unlike spiritualism, shares some crucial features with it : empiricism. As Van Fraassen sees them, both empiricism and materialism are characterized by their fascination for science (unlike spiritualism which relies on the pre-scientific ubiquitous fact of *experience)*. But empiricism and materialism do not emphasize the same side of science. Empiricism takes the *methods* of a developing scientific research (including acceptance of future developments, and interpretational pluralism) as its highest value, whereas materialism is faithful to the *contents* of a dominant scientific discourse mature enough to present its own statements as *truths*. Empiricism incorporates a thorough critique of metaphysics, especially of analytic metaphysics as a mere shadow of logic, within its own identity. Materialism rather tends to resuscitate a certain metaphysical view by grounding it into the (real or alleged) ontological commitment of scientists. Empiricism remains open to the specificity of first-person experience (and to contemplative enhancement of this experience[9]) although, unlike spiritualism, it does not endow it with metaphysical significance. By contrast, many materialists are averse to ascribing any other status to experience than "subjective" appearance, or "private theater"[10], because, being caught in a metaphysical controversy, they fear that any concession could favor the opposite metaphysical position, to wit spiritualism. Accordingly, when they deal with the *contents* of scientific discourse, the empiricist's attitude and the materialist's attitude are utterly different. In so far as he adheres to a branch of scientific anti-realism, the empiricist claims that " (...) a theory can at best replace real life by a phantasm, even if it is of a particularly useful and survival-adaptative sort "[11]. The empiricist here shares Husserl's reluctance for the "substructions" of science when they are presented as more real than the "life-world (Lebenswelt)" itself, despite their being underpinned by the latter. But a materialist, who adheres to a branch of scientific realism, rather takes for granted that scientific theories enable us to cut through the appearances of everyday life and reach reality itself, *qua* intelligible, beyond these appearances.

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[9] B. Van Fraassen, *The empirical stance,* op. cit., p. 193

[10] B. Van Fraassen, *The empirical stance,* op. cit., p. 184. The expressions "subjective appearances" or "private theater" would certainly not be adopted by every materialist. "Private theater" is rejected from the outset by D. Dennett. As for J.J.C. Smart, "Materialism", in : A.G.N. Flew & C.V. Borst (eds.), *The Mind/Brain Identity Theory*, The Mac Millan Press, 1970, he writes that materialists construe experience as "goings-on (…) taking place in our skulls". But the basic idea expressed by Van Fraassen at this point is perfectly right. For an empiricist and a phenomenologist, experience is an all-pervasive primitive *faktum*, to be taken as a starting point. Whereas, for a materialist, experience is a localized and derivative process.

[11] B. Van Fraassen, *The empirical stance,* op. cit. p. 178

To recapitulate (by using a traditional distinction), for an empiricist, the paradigm of reality is *immanent*, whereas for a materialist and a spiritualist as well it is *transcendent*. Of course, the materialist's transcendence is distinguished from the spiritualist's transcendence; the first one is allegedly forced upon us by the scientific discourse, while the second one is motivated by the conviction that there is more to the world than what science can reveal. But the attempt at figuring out transcendence is common to both metaphysical positions, whereas empiricists content themselves with permanent *open-mindedness* towards it.

2-About the "nature" of matter

Let us now assume that materialism is indeed a stance, that it relies on the ever-changing characterization of matter by science, rather than on a precise definition of matter. The problem is that, in this case, the materialist " solutions " to several conundrums of philosophy are seriously challenged, not because they are provably wrong, but because one cannot even formulate them univocally.

The central conundrum bears of the issue of the "nature" of matter. If a direct and definitive answer to the question " What is matter? " were out of reach, there might still be the resource of positing a demarcation line between what is acceptable as material process and what should be rejected as spiritual or magical. The challenge would then be to formulate the demarcation criteria in such a way that they remain stable despite the endless development of concepts in physics. But as Van Fraassen shows with some irony in his book, this also proves extremely difficult. I'll thus begin, in this section, with showing why it is so difficult. But I'll part company with Van Fraassen at a certain point : difficult does not mean impossible. Eventually (in section 4), I'll posit a plausible, though probably too general, demarcation line between material and non-material entities.

Let me first recall a few classical demarcation criteria between the material and the non-material, following lecture 2 of *The Empirical Stance*. The most ancient mark of materiality is spatial extension. Several Greek post-aristotelian thinkers such as Plotinus and John Philoponus thought that spatial extension belongs to the *ousia* of material bodies. John Philoponus thus wrote that "(…) the substance of body is nothing other than the indefinite three-dimensional which is made definite by the *differentia* of smallness and largeness (…)"[12]. A material body could be defined accordingly as a fraction of *space* endowed with essential *properties* such as impenetrability and mass. Moreover, this fraction of space could only manifest its properties by direct contact with another one, namely by spatial coincidence of their two boundaries. In the

[12] R. Sorabji, *Matter, Space & Motion,* Duckworth, 1988, p. 29

seventeenth century, this definition was retained, but a turn from ontology to epistemology was taken. The reason why Descartes thought the very *nature* of material bodies is spatial extension, was no longer that he identified spatial magnitude with substance as a category of being. His motivation was rather that bodies can still be clearly *conceived* by us if we make abstraction of their qualities, but not if we make abstraction of their spatial extension.

Unfortunately, if one sticks to this definition, many later developments of physics appear to have blown out the limits of materiality, and, by cartesian standards, the limits of clear and distinct intelligence as well. To begin with, action by (spatial) *contact* was soon outmoded by Newtonian *action at a distance*. This created resentment in the materialist circles of the end of the seventeenth century, who feared the resurgence of occult qualities. But later on, the model of gravitational force was incorporated within the materialist framework of thought. Kant's definition of matter as a system of coexisting centers of repulsive and attractive forces became quite popular by the end of the eighteenth century. Then, along with this rise of action at a distance as the norm of physics, the dominance of spatial extention faded away. Following Van Fraassen[13], one can mention Hertz's massive point particles, which are without extension. Should we keep on with the old criterion of extension and say that they are immaterial? Or should we follow the physicists of the end of the nineteenth century who finally considered point particles as paradigmatic instances of matter? A materialist may try a rearguard defense of extension as " essential " to matter, by claiming that point particles are idealizations. But in this case he/she is coming dangerously close to accepting that physics deals with idealizations throughout in its struggle towards " saving the phenomena ". And, therefore, that matter itself might be such an idealization. The materialist may also retreat at this stage, accepting that it is enough for a material entity to be : (a) permanently *located in space*, (b) causally connected to changes in its *spatial* environment, and (c) endowed with mass (wasn't mass called the 'quantity of matter' by Newton, in Definition 1 of his *Principia* ?). But then quantum mechanics comes in, and the three criteria are threatened. A quantum particle can be located experimentally at some given time; but ascribing it a precise location *at any time,* and a strict causal connection of its properties, is tantamount to believing in hidden variable theories[14]. Even mass hardly resists some consequences of quantum physics. Indeed, the mass-generating mechanisms of Quantum Field Theories (energy of mutual binding and Higgs' mechanism) deprive mass from its traditional status of a "fundamental", "intrinsic", feature of material bodies.

At this point, I can formulate my major objections against Van Fraassen's attack against materialism. In a few words, this attack is not radical enough :

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[13] B. Van Fraassen, *The Empirical Stance,* op. cit., p. 51
[14] ibid. p. 52

(1) The case for the particulate conception of matter is much weaker than what Van Fraassen states. Van Fraassen's position is that, despite its ontological clumsiness, and even in view of Quantum Field Theory that seems to be able to dispense with it (see section 3 below), this conception is still acceptable today[15]. Such a statement of acceptability is allowed by Van Fraassen's use of a "principle of tolerance". In his own wordings, a study of the issue of indiscernible particles in quantum physics "(…) open(s) up a manifold of possible interpretations, in principle all equally tenable and capable of doing justice to physics"[16]. Here, the particulate conception is one among many of those tenable interpretations.

But I disagree with this application of the principle of tolerance. According to Carnap, the principle does not exclude an evaluation of the pragmatic advantages of each view. Now, if the pragmatic advantages of the particulate conception are assessed, one discovers that they are scarce. The only reason why it is still popular among physicists is that it allows a loose verbal articulation between *certain types* of experimental data (such as tracks[17] or clicks) and the formalism, while maintaining an apparent continuity between macroscopic and microscopic entities. But in the field of philosophy, where the strongest criteria of unity and coherence of discourse are taken as dominant norms, loose articulation should not be taken as sufficient. The fragmentation of the domain of discourse that is imposed by the attempt at patching up a particle-like representation with various types of experimental accounts, and with a formalism that is essentially foreign to it (as Heisenberg[18] already pointed out in 1926, and as it is even more obvious when Quantum Field Theory comes in), should serve as a deterrent. True, an empiricist philosopher of science is likely to reply that she is not concerned by any strong requirement of unity of the range of representations associated with a given theory ; that one should accept the fragmented system of pictures and formalism which is currently used by scientists (provided it has proven its efficacy). But beware. If one is exceedingly indulgent to pictures, the same is likely to occur as when one is indulgent with "(…) the fascination which forms of expression exert upon us"[19] : metaphysical reification. To preserve the intellectual flexibility an empiricist philosopher tends to ascribe to science, it could then prove indispensible to adopt a therapeutic attitude towards artificial pictures. This is the reason why I am inclined to be systematically dismissive about the particle-like picture ; much more at any rate than Van Fraassen is.

(2) By taking almost exclusively into account the positions of the most advanced materialist philosophers (those who take carefully into account the

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[15] B. Van Fraassen, *Quantum Mechanics, An Empiricist View,* op. cit., p. 448

[16] ibid. p. 460

[17] See the accurate analysis of the observational status of tracks in B. Van Fraassen, *The Scientific Image,* Oxford University Press, 1980, p. 17

[18] W . Heisenberg, *Physics and Beyond, Encounters and Conversations,* G. Allen & Unwin, 1971, chapter VI

[19] L. Wittgenstein, *The Blue and Brown Books,* Basil Blackwell, 1993, p. 27

advances of physics), Van Fraassen is not strong enough in his denunciation of what I perceive as an *ontological conservatism* of the bulk of materialist thought.

True, advanced materialist philosophers of physics such as Michael Lockwood (see section 4) usually do not feel that their position is threatened by articles such as P. Davies's ("Particles do not exist"[20]) or H.D. Zeh's ("There are no quantum jumps nor are there particles !"[21]). After all, these papers reactivate a devastating criticism against particle-like representations already formulated by E. Schrödinger[22] long ago in the framework of Standard Quantum Mechanics. This did not discourage advanced materialist philosophers of physics in the past (even when they took the former arguments at face value), but rather prompted them to wonder how to conceive the nature of matter in a way that would be in line with the physics of their time. A good example is G. Bachelard, who fully aknowledged the extreme strain exerted by quantum physics on the concept of corpuscle[23], and strongly criticized the ideology of "things", but still declared during the mid-1930s that microphysics should be construed from a *materialist* standpoint[24]. Matter concepts are made meaningful in the context of modern physics, according to him, if they are taken as describing *sudden stochastic transformations of energy*, rather than corpuscles.

However, many champions of materialism are averse to such advanced readings of Quantum Physics, and they tend to resist them by using any expedient at their disposal. This is especially true of materialist philosophers outside the philosophy of physics community, such as D. Lewis. Lewis thus rejects from the outset those criticisms against his idea of "humean supervenience" (e.g. supervenience of global properties on a distribution of local properties) that are inspired by quantum physics, especially by quantum non-separability[25]. His feeling is that quantum physics is too exotic, and that its interpretations are too controversial, to be taken seriously in philosophy. Classical physics is therefore taken by him as the only firm basis for such philosophical discussions.

Looking backwards here again appears to be a crucial component of the materialist stance. This is an additional reason why Van Fraassen ought not to be too benevolent about it, even in name of the 'principle of tolerance'. He should rather remind one that the empiricist's stance is more progressive, more prone to historical boldness than the materialist's stance (as suggested, e.g., by the

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[20] P.C.W. Davies, "Particles do not exist", in : S.M. Christensen (ed.), *Quantum Theory of Gravity,* Adam Hilger, 1984. The paper is referred to in B. Van Fraassen, The *Empirical Stance,* op. cit. p. 52

[21] H.D. Zeh, "There are no quantum jumps, nor are there particles", *Physics Letters,* A172, 189-192, 1993

[22] E. Schrödinger, *The Interpretation of Quantum Mechanics,* Ox Bow Press, 1995 ; M. Bitbol, *Schrödinger's Philosophy of Quantum Mechanics,* Kluwer, 1995

[23] G. Bachelard, *L'activité rationaliste de la physique contemporaine,* Presses Universitaires de France, chapter III

[24] G. Bachelard, *Le nouvel esprit scientifique,* Presses Universitaires de France, 1934, p. 61-63

[25] D. Lewis, *Philosophical Papers 2*, Oxford University Press, 1987, p. XI,

tropism towards empiricism of many great actors of scientific revolutions, at least during the crucial moments when they were in the midst of these revolutions[26]).

These two reinforcements of Van Fraassen's attack against materialism will be considered in turn.

3-The cognitive conditions of the concept of material body : macrophysics and microphysics

In this section, I will concentrate on point (1) above. My aim will be to show that, at the microscopic scale, the notions of material body and material point as objects of knowledge are deprived of the most basic cognitive conditions of their applicability.

The approach I will be using here is typically neo-Kantian. It contrasts with both empiricism and materialism. A constructive empiricist can accommodate isolated fragments of the picture of material bodies at the microscopic scale, provided these fragments partake of one of the models of a theory that is empirically adequate. A materialist tends to stick to body-like representations as a paradigm of her position (even though evolution of these representations is allowed to a certain extent). But a neo-Kantian is bound to ask : "Can we *constitute* objects belonging to the type of material bodies at the microscopic scale, out of a set of properly selected phenomena ? Are the conditions for such an active process of constitution of objects fulfilled at all ?". If the answer to these questions are negative, the neo-kantian reaction consists in giving up any reference to material bodies, and starting a process of constitution of objectivity afresh[27].

A good way to enquire into the cognitive conditions of the "constitution" of material bodies is to borrow concepts from J. Piaget. This author indeed offered a pragmatic and genetic equivalent of Kant's conception of knowledge that proves much more adaptable to modern physics than the original scheme of the *Critique of Pure Reason*. Firstly, Piaget replaced Kant's *a priori* forms of sensibility (to wit space and time) with motor activity, whose coordination generates the group structure of euclidean space ; this is the pragmatic aspect of his epistemology. Secondly, Piaget denied that "a priori" means immutable. He rather described a process of development of our cognitive pre-suppositions in two steps : assimilation and accommodation. Assimilation means incorporation

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[26] Newton's « Hypotheses non fingo », Einstein's operational definition of length and duration in 1905, and Heisenberg's « reduction to observables » in 1925, are three well-known examples.

[27] P. Mittelstaedt thus proposed to consider that the locus of quantum objectivity is no longer ordinary space-time, but rather Hilbert spaces ; and that the counterpart of Kant's substance (to wit the permanent focus of a class of phenomena) is the *state vector*. P. Mittelstaedt, *Philosophical Problems of Modern Physics,* Reidel, 1976, p. 119. Similarly, J. Petitot claimed that the locus of quantum objectivity is the space of *spectra* (rather than their Fourier Transform in ordinary space). J. Petitot, "Objectivité faible et philosophie transcendantale", in : M. Bitbol & S. Laugier, *Physique et réalité, un débat avec Bernard d'Espagnat*, Editions Frontières, 1997

of familiar features of the environment within the subject's pre-existing schemes of motor activity. Accommodation means reorganization of the subject's schemes of motor activity in order to be able to assimilate new types of features. Once accommodation has been successfully performed, assimilation can proceed. A new steady state of the cognitive apparatus is established for an usually long period. This relative stability of the accommodated state is an attenuated version of the permanence and strict necessity of Kant's *a priori* forms (of sensibility and thought).

Let me now develop Piaget's reflections on microphysical objects. In his *Genetic Epistemology,* J. Piaget illustrated the loss of the cognitive conditions for the notions of material body and material point in quantum physics. He compared the situation of a specialist of microphysics[28] with the situation of a young child, who has to constitute these notions by coordinating his/her motor activity. According to Piaget, "The present specialist of microphysics imposes himself, as a scientific ideal, a sort of return to a primitive state ; but an intentional and very lucid return. He tries to recover a mentality unsullied by any preconceived idea, since his individual actions are close to the limits of the scale where they are still efficient. In the same way as the young child, he forces himself to believe in objects only insofar as he can *find* them *again* ; and he wants to know about space and time only that part that he is able to *construct* by piecing together one by one the elementary relations of position, of displacement, of form etc" [29]. Piaget's "return to a primitive state" thus amounts to reassessing entirely the embodied preconditions of objective knowledge, instead of extrapolating them blindly. It first forces one to bracket any reifying projection of the structure of the objectifying procedures, and to suspend ordinary belief in material bodies existing independently of such procedures. It then encourages one to generalize our organizing schemes beyond the motor schemes of everydaylife, and to gain reflective understanding on how these schemes yield the constitution of objects. Just in the same way as a young child, says Piaget, a specialist of microphysics "(…) does not believe in the permanence of individual objects until he is able to let it emerge by his coordinated actions (…). He rather *constructs* the notion (of permanence) as soon as the actions of finding again can be performed" [30]. Of course, there is also

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[28] W. Heisenberg serves as a model of such a specialist, and the Copenhagen-like writings of L. de Broglie are used as a major source by Piaget. See e.g. L. de Broglie, *La physique nouvelle et les quanta,* Flammarion, 1937

[29] J. Piaget, *Introduction à l'épistémologie génétique, 2-La pensée physique,* P.U.F., 1974, p. 226 (The translation is mine)

[30] ibid. p. 222. Doubts have been formulated recently about the validity of Piaget's stages of acquisition of the scheme of permanence. Several authors claimed that newborn babies already possess it somehow, suggesting directly or indirectly that they might have inherited it from earlier stages of biological evolution (E.S. Spelke, "Nativism, empiricism, and the origin of knowledge", *Infant Behavior and Development,* 21, 181-200, 1998). However, a strong counterargument was developed in : E. Thelen and V. Whitmyer, "Using dynamic field theory to conceptualize the interface of perception, cognition and action", http://www.indiana.edu/~cogx/. A careful evaluation of the whole debate can be found in : I. Peschard, *La réalité sans représentation,* Thèse de doctorat d'épistémologie de l'Ecole Polytechnique, 2004.

a difference between the specialist of microphysics and the young child. “The specialist of microphysics does not content himself with rejecting notions if they exceed effective action (…)”. He builds “(…) an entire system of intellectual and mathematical operations” in order to formalize the partial disappearance of the performative pre-conditions of the notion of material body, yet being still able to predict the consequences of his experimental actions.

In his pioneering studies of genetic psychology, J. Piaget listed the motor schemes of reversibility which give ground to the idea that there is something permanent or substantial retaining its own *identity* across space-time[31] ; a “ something ” which is endowed with *properties*, and which can *cause* events. However, none of these motor schemes of activity is available at the micro-scale[32]:

(1) The scheme of identity requires the possibility of restoring the continuity of spatio-temporal trajectories in order to follow them ; but, in view of Heisenberg’s uncertainty relations, no such trajectory is accessible to experience except for situations of very low density.

(2) The scheme of definition of properties requires reproducibility of phenomena across a large range of variation of perceptive or experimental history. But in quantum physics, when some pairs of measurements (those which bear on conjugate variables) are performed sequentially, the result of each type of measurement crucially depend on the order of the sequence.

(3) The scheme of definition of ordinary causality requires free substitution of well-defined antecedent conditions in order to check that a certain effect is determined (or probabilistically promoted) by some antecedent. But, in quantum physics, this definition cannot be applied to its usual mechanical object, to wit *motion*. For, once again due to Heisenberg’s uncertainty relations, it is impossible to specify completely the spatial and kinematic antecedent conditions of a process of motion. Therefore, if the law of causality is still relevant in quantum physics, it cannot apply directly to spatio-temporal bundles of phenomena such as material bodies. The law of causality and the description of phenomena in space-time, writes Bohr, are *complementary*.

This means that all the schemes of reversibility which justify our belief in the existence of spatio-temporal objects called material bodies, are *missing* at the microscopic scale. Taking this failure of the cognitive ground of the concept of material bodies at face value, one is inclined to say that *material bodies are no longer the basic objects of physics*[33]. Matter can no longer be thought of as being made of elementary parts of itself (as it was the case in the traditional atomist model, wherein the properties of macroscopic material bodies were explained by

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[31] J. Piaget, *La construction du réel chez l’enfant,* Delachaux et Niestlé, 1977

[32] M. Bitbol, *Mécanique quantique, une introduction philosophique,* Flammarion, 1996; M. Bitbol, *L’aveuglante proximité du réel,* Flammarion, 1998 ; M. Bitbol, *Schrödinger’s Philosophy of Quantum Mechanics*, Kluwer, 1996

[33] M. Bitbol, “Le corps matériel et l’objet de la physique quantique”, in: F. Monnoyeur (ed.), *Qu’est-ce que la matière?* Le livre de Poche, 2000.

the properties of the microscopic bodies they are made of). What one can say *at most* is : (a) that the pragmatic-conventional notion of material body at our scale was the triggering motivation of research in the early history of physics ; and (b) that the predictions of microphysical theories are compatible with the emergence of body-like appearances at the macroscopic scale. Ironically, the notion of material body motivated the research that eventually dissolved it.

On the face of it, two strategies are available to those who want to preserve something of the good old atomistic view. The first strategy corresponds to the pragmatic attitude of most physicists ; and the second strategy identifies with the daring attitude of the proponents of hidden variable theories.

Most physicists still speak of " particles of matter " in a quasi-mereological sense. Their system of thought which combines the formalism, the empirical correspondence rules, and these guiding atomistic representations, is efficient. Yet, when they use the word " particle ", it is with so many qualifications that virtually nothing is retained of the familiar notion of material body. What I wish to emphasize here is that these qualifications convey a list of awkward features which come close to inconsistency, and that therefore the associated atomistic representation does not stand up alone. Were it not for the operational value of the research program in which it is embedded, and the need for historical continuity it fulfills, this representation would soon be relinquished.

Let me discuss briefly two of these qualifications. One of them has now only a popularizing function, but its persistent use shows that physicists are still fascinated by it[34]. It amounts to saying that "particles" are no longer corpuscle-like, but that they are "wavicles" (sorts of chimera made of continuous and discrete aspects). However, this is only a picturesque way of describing a procedure that enables one to predict distributions of discrete events (impacts, clicks or sequences of bubbles) by means of wave-like formal symbols (wave-functions). The overall procedure (including the heuristic value of the representation) works, but not the representation as such. *Nothing* is left either of the notion of a localized spatio-temporal continuant that can be called a corpuscle, or of the notion of an even distribution of energy that can be ascribed to a wave. Localized experimental *events* and distributions of *probability* are no substitute for the former notions.

The second qualification is much more serious, since it is used in professional context, including in philosophy of physics. It consists in pointing out that the postulated particles are "non-individuals". But, here again, this name is only a verbal illustration (and probably one of the motivations) of a mathematical procedure. This procedure is well-documented in Van Fraassen's *Quantum Mechanics, an Empiricist View*. It consists in ascribing different labels to physical sub-systems, and then wiping out the consequences of these

[34] I recently heard Alain Aspect presenting the "wavicle" model very seriously to an audience of journalists, although he eventually mentioned that he only accepted it as an awkward combination of visual concepts able to guide him in experiments.

postulated differences by means of symmetrization and anti-symmetrization rules. The first step of the procedure gives ground to the tentative use of the word "individuals", whereas the second corrective step is expressed by using the preposition "non-". The complete procedure is to a certain extent acceptable. It provides physicists with an alternative to Quantum-Field Theoretical procedures. At least, it does so in a restricted domain of validity wherein treating the number of "particles" as a mere *observable* submitted to a Heisenberg's inequality, is not indispensible. But I definitely disagree with Van Fraassen when he says that, in view of the acceptability of this *procedure*, the many-particle *interpretation* cannot be ruled out. An interpretation should stand up alone as a self-coherent whole, not as a verbal appendix of a formal method ; especially when the interpretation cannot acquire any autonomy with respect to the method, or when it irresistibly transforms into another interpretation as soon as one attempts to endow it with the sought autonomy. But the latter is exactly the case of the many-particle interpretation. Let me review two ways in which this irresistible transformation occurs.

(i) Wiping out (experimental) consequences of the labeling by symmetrization or anti-symmetrization rules means that any permutation of "particles" is irrelevant. This fact of irrelevance is hardly accounted for by the isolated remark that particles are "indiscernible" ; after all, the material points of classical physics were also indiscernible, with the exception of their spatial coordinates. It would be less inappropriate to say that particles are spatially mixed up in permutations because their trajectories (which are the only criteria of identity left for indistinguishable entities) overlap, in view of Heisenberg's inequalities. But in the latter case, one is left with the representation of elements that are permutable in principle, but whose permutation is unknowable. And this representation is an irresistible incentive to the search for hidden variable (Isn't it tempting to inquire into what is said to be unknowable, when the said "unknowable" domain is nonetheless figured out ?). By contrast, it is much more natural, and much less tantalizing, to accept that the reason why particles cannot be permuted to one another's state or position is that there are *no* such particles in states or positions *at all*, but only states or positions with a certain occupation number. This is exactly what is done in Quantum Field Theory.

(ii) The most advanced attempts at finding some coherence in the many-particles interpretation yielded the so-called quasi-set theory[35], in which one assumes the existence of *sorts* that are not instanciated by individuals but have an order of multiplicity ("sets" that have no ordinal but only a cardinal). Now, this ontology is remarkably isomorphic to the Quantum Field Theoretical procedure, which involves specific fields and a number of quanta for each field ; with the crucial *proviso* that this number of quanta should be well-defined according to the many-particle representation, whereas it is a dispersed value of

[35] D. Krause, "On a Quasi-Set Theory", *Notre-Dame Journal of Formal Logic,* 33, 402-411, 1992

an observable in Quantum Field Theory. This being granted, the many-particle method appears as a restrictive special case of the Quantum Field Theoretical method. So much so that one can safely declare that the Quantum Field Theoretical procedure acts as a sort of attractor of interpretations, and that the many-particles interpretation willy-nilly merges into it.

Other qualifications concern "properties" (that are assimilated to projectors on eigendirections of contextual observables, rather than to true inherent determinations), and "trajectories" (that are represented in Feynman diagrams, but admittedly as symbols for terms of a path integral which adds up an infinite number of them). With respect to their classical model, these qualifications imply much more than a loss of content : a complete inversion of meaning. Intrinsic is replaced by relative (for "property"), and unique by indefinitely multiple (for "trajectory"). This is one more strong argument against the autonomous validity of the particulate picture within the usual pragmatic attitude of physicists.

The second strategy, to wit hidden variables, is still available at this point. To be sure, this strategy has some value as a prop for intuition. And it has proved its viability thanks to Bohm's theory. As Van Fraassen rightly pointed out[36], the very existence of this theory showed that the Copenhagen Interpretation could not claim hegemony.

Yet, hidden variable strategy has a defect that was denounced soon in the history of quantum mechanics, even before Von Neumann's theorem was (mistakenly) interpreted by the physicists of the Copenhagen group as a final blow against hidden variables. This defect is that it is "metaphysical" in the most speculative sense, since a majority of its proponents aknowledge that its "surplus structure" is immune to empirical test. One can even safely guess that no future extension of the experimental domain will provide us with a crucial test, in so far as this immunity is *built in* the contextualism that is typical of Bohm's theory, and that makes it predictively equivalent to standard Quantum Mechanics.

The problem is that, whereas this argument of "metaphysical excess" looks compelling from an empiricist standpoint, there is little prospect of ever impressing advocates of hidden variables with it. They have at least two reasons for resisting it.

Firstly, they can rightly point out that saying, as in the patchwork-like "orthodox" interpretation, that there are particles which sometimes have a position and sometimes none, seems to be metaphysical too ; and that this sort of metaphysics is less coherent than theirs. In order to provide a really non-metaphysical alternative, one should therefore remain consistent throughout in the formulation of an empiricist interpretation of quantum mechanics. Promoting consistency would here mean either enforcing a literally bohrian view, in terms

[36] B. Van Fraassen, *The Empirical Stance*, op. cit. p. 144

of a predictive "symbolism" applying to experimental outcomes[37], or defending a purely information-theoretic version of quantum mechanics[38].

Secondly, hidden variable theorists are likely to advocate the dignity and usefulness of metaphysical superstructures in physics for the sake of *explanation*. They can contrast the explanatory value of their "metaphysical" constructions with the (too) modest task of "saving the phenomena" undertaken by empiricist versions of quantum mechanics.

It could then be useful to elaborate a third position in the debate, a transcendental rather than empiricist version of the charge of being "metaphysical", with some hope that this alternative position may help to overcome the former counter-arguments of the hidden variable theorists.

My transcendental approach is, once again, inspired by Piaget. It consists in claiming that objects are somehow *constituted* by motor schemes and research activities.

This *constitutive* conception goes well beyond mere theory ladenness of "facts", and model-dependence of laws, that are both accepted in Van Fraassen's Constructive Empiricism. One crucial difference is that neo-Kantian philosophers *cannot* accept the sort of half-way attitude which is adopted by Van Fraassen about the issue of the truth of scientific theories. According to this half-way attitude : (i) the *acceptance* of a given theory does *not* involve the belief that it *is* true, but only that it is empirically adequate, and (ii) the alleged independent existence and intrinsic properties of "non-theoretical entities"[39] nevertheless justifies the idea that theories *might* be *true* in the strongest, correspondentist sense. By contrast, neo-Kantian philosophers do not ascribe truth any meaning at all independently of the experimental and technological activities that are at the same time guided by the theory, and able to support the theory by their efficacy. Truth (of a theory) here can by no means be thought of as "correspondence" (with objects), because the objects are not endowed with existence independently of the procedures that generate both the phenomena and the possibility of extracting invariant structures out of them. Indeed, the objects are merely *identified* with these invariants.

Within this conception, it is easy to reformulate and reinforce the charge of metaphysical excess. In a few words, speaking of spatio-temporal continuants whose path is beyond any possibility of following it, and trying to apply the scheme of identity to it, is tantamount to severing them from the very

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[37] N. Bohr, Atomic Physics and Human Knowledge, Ox Bow Press, 1987, p. 40 : "(T)he quantum mechanical formalism (…) represents a purely symbolic scheme permitting only predictions (…) as to results obtainable under conditions specified by means of classical concepts"

[38] A. Zeilinger, "Foundational principle for quantum mechanics". *Foundations of Physics*, 29, 631-643, 1999 ; A. Grinbaum, "Elements of information-theoretic derivation of the formalism of quantum theory", *International Journal of Quantum Information*, 1, 289-300, 2003 ; C.A. Fuchs, "Quantum mechanics (and only a little more)". In A. Khrennikov (ed.), *Quantum Theory: Reconsideration of foundations*, Växjo University Press, 2002.

[39] B. Van Fraassen, *The Scientific Image*, op. cit. p. 214

performative basis of their *definition*. Hidden variable theorists posit objects (particles with a definite trajectory) which are made completely independent on the conditions that specify them as permanent units in the flux of experimental outcomes. This move is not just over-speculative. It is self-contradictory : like positing ordinal numbers with no ordering procedure, or claiming that dance may exist without gestures. For an empiricist, the hidden variable theorist is guilty of trying to figure out a domain of entities or processes without any *additional* empirical support (with respect to theories that do not involve these entities or processes). But for a transcendentalist, things are even worse : what the hidden variable theorists are trying to do is imposing a cut between objectivity and the performative presuppositions of objectification ; a cut between the objects and the network of active variations of phenomena from which they emerge as (mathematically formulated) invariants. Notice that such a cut is virtually unprecedented in the history of modern science. Even the atomism of nineteenth century physics and chemistry, which is taken as a paradigm by hidden variable theorists, is no counterexample. Classical atoms were *in principle* liable to the same tracking procedures as mesoscopic bodies, whereas Bohm's particles *must* be thought of independently of them, since their trajectory is supposed to be contextualistically influenced by any apparatus able to follow it. The interpretational situation is thus really exceptional. For the first time, one proposes to cut objectivity from its ever developing constitutive cognitive matrix, for the only sake of sticking to a form of objects (material body) which was constituted at an earlier stage of cognition.

As I noticed earlier, the appropriate strategy in this situation is neither to keep on referring to fancied objects, nor to content oneself with merely *prohibiting* excessive acts of imagination in view of their inaccessibility to empirical tests. It rather consists in framing *new* procedures of constitution of objectivity and making good (non-metaphysical) sense of the types of objects that arise from them. Bohm himself adumbrated some of these new procedures, being dissatisfied of his 1952 theory. What he proposed can shortly characterized as follows : objectify the reasons for the non-objectifiability of spatio-temporal continuants ; objectify the entire process (or "holomovement") of which the experimental phenomena partake, without trying to cut it into spatio-temporal slices. The attempt yielded an interesting negative result : in the mature view of Bohm, the particles and trajectories of the original hidden variable theory *are not to be taken as elements of reality*. "(…) Particles are no longer considered as autonomous and separately existent" ; "(…) the word 'electron' should be regarded as no more than a name by which we call attention to a certain aspect of the holomovement (…)"[40].

Now, does this transcendental account fulfill the urge for explanations ? It does not fulfill the need for direct, first-order, naturalist explanations in the

[40] D. Bohm, Wholeness and the Implicate Order, Ark Paperback, 1983, p. 155

traditional constituted domain of material bodies. However, it does not restrict itself either to Van Fraassen's cogent remarks about the lack of value of facile "explanations" in the metaphysical style[41]. For the transcendental approach at least provides us with two alternative types of explanation :

(1) Reflective explanations of why standard explanations in space-time are no longer available in the microscopic domain. Here, the "why-question"[42] to be answered has been displaced, just as much as the explanation itself.

(2) Explanations of phenomena within a completely new frame of objectified elements, appropriate to the present state of microphysics. One may thus contend that time evolution of more or less entangled state vectors should itself be recognized some explanatory value.

To recapitulate : artificiality, lack of conceptual unity, metaphysical excess, or even complete severance from constitutive presuppositions, are some of the reasons why I cannot share Van Fraassen's neutrality towards the particulate model of matter, and rather tend to criticize it openly. But, as we will now see, there are also other reasons.

4-Materiality and Objectivity

If taken at face value the conclusion of the former section could well be that the object of quantum physics is no longer *matter* in any usual sense. An alternative conclusion is that permanent location can no longer be taken as a *necessary* condition of materiality. Since permanent location is not a sufficient condition either (a geometrical point may be permanently located), one must try to formulate another set of criteria that include the quantum objects yet exclude geometrical points. To include quantum objects, the condition of permanent location must be abandoned, although the possibility of being located instantaneously should stay; and to exclude abstract geometrical points one may add the condition of phenomenal manifestation or manifestability.

Would it be enough, then, to assume instantaneous locations here and there (in an unpredictable way) *plus* phenomenal manifestation at these points as a satisfactory set of criteria of materiality? Not really either: as Van Fraassen rightly mentions, angels or ghosts also were sometimes said to manifest here and there in space-time to some priviledged human beings. True, as evoked by Balzac in his novel *Louis Lambert,* some authors in the past declared that, for this reason, angels or ghosts are indeed made of some subtle continuum of matter. But angels and ghosts are precisely the sort of entities a materialist would like to keep outside the demarcation line.

What should materialists do at this point? Is it true, as Van Fraassen suggested in a discussion of J.J.C. Smart's conception of matter, that *whatever*

[41] B. Van Fraassen, *The Empirical Stance,* op. cit., p. 37
[42] B. Van Fraassen, *The Scientific Image,* op. cit., p. 141

physics tells us (or will tell us) is likely to be taken by materialists to provide "(…) new visions of the structure of the *material* world"[43] ? Scanning some recent literature, I realized that this characterization of the materialist stance by Van Fraassen might be too general. Indeed, several materialist thinkers strongly resist any flat identification of the material with the physical.

An interesting case, because it looks very daring, is M. Lockwood. Michael Lockwood declared to me repeatedly that he regards himself as a materialist but not a physicalist thinker[44]. The reason for his reluctance towards physicalism is that " (...) there may be more to matter than can be captured in the language of physics, more than any description couched purely in the language of physics is capable of conveying "[45].

A similar position is instanciated by R. Penrose, when he develops the idea of a non-computable physics. Here, everything can somehow be *encompassed* within physics, yet *not mastered* by calculations. This is not materialism without physicalism (unlike Lookwood), but materialism with loose physicalism (which has exactly the same consequences). This is materialism, since, according to Penrose, only by disclosing the "nature of matter" could one "(…) understand what kind of organization it is, in the physical world, which gives rise to conscious beings" [46]. This is also physicalism, since matter remains within the scope of an *ideal* physics. But Penrose also accepts that the aim of making exhaustive sense of matter within *any actual* physics is out of reach : "(…) the more deeply we examine the nature of matter, the more elusive, mysterious and mathematical, matter itself appears to be"[47].

Loosening the connections between physics and the materialist position raises a difficult question. What is the benefit of holding a materialist position with respect to, say, mind-body dualism, if this materialism *also* postulates an order of things which is *in principle* out of reach of any calculation within physics? Well, it seems to me that there is still a difference, but a very subtle difference of *attitude* in the way the supporters of the two sets of doctrines tackle the elusive order of things they both aknowledge. A dualist or a spiritualist thinks that the present or future loopholes of physics are a sufficient reason for positing a second domain of being. By contrast, a materialist like Michael Lockwood is happy to live with the incompletion of physics, rather than trying to speculate beyond it. And a physicalist like Roger Penrose also accepts a *constitutive incompleteness* of the original project of physics, insofar as there exist physical processes that are intrinsically non-computable[48]. Both authors

[43] B. Van Fraassen, *The Empirical Stance*, op. cit., p. 57
[44] Private discussions with Michael Lockwood, Oxford, Summer 2003
[45] M. Lockwood, *Mind, brain and the quantum,* Basil Blackwell, 1989, p. 20
[46] R. Penrose, *Shadows of the Mind,* Vintage, 1995, p. 419
[47] ibid.
[48] R. Penrose, *Shadows of the Mind,* Vintage, 1995, Chapter 4

illustrate the way Erwin Schrödinger defined the scientific attitude: " Instead of filling a gap by guesswork, genuine science prefers to put up with it "[49].

One could object at this point that open-mindedness towards the lacunae of scientific theories, and stubborn suspension of judgment is more consistently maintained by empiricists (and neo-Kantians as well) than by materialists ; for the latter are still under the spell of a word ("matter"), as well as of its familiar explanatory pictures. By contrast, one sees examples of a strategy of complete *epoche* in Van Fraassen's *Quantum Mechanics, An Empiricist View* : "(…) interpretations which 'explain' (EPR correlations) through action at a distance 'behind the phenomena', simply add mystery to mystery". And a few lines after : "(The) search for understanding would not be aided but hindered by insistence that every regularity must have a reason"[50]. Preferring no reason to bad reasons is typical of the empiricist and neo-Kantian *stances*.

After all, if the scientific undertaking has limits, why should we stick on them the label *" matter "*, with its old-fashioned connotations of " extended impenetrable stuff "? Isn't it a way of hiding our ignorance with a *flatus vocis*? Shouldn't we rather keep on with the strict agnosticism of the empiricists and the neo-Kantians? I then suspect that there must be additional motivations to materialism. I think these additional motivations are essentially protective. They are: (1) fear of an uncontrolled skid towards pre-scientific thought, and (2) ontological and methodological conservatism taken as an insurance against such a skid. The first motivation is likely to be shared by empiricists and neo-Kantians, whose position historically arose from the project of making sense of the science of their time. But the second motivation is definitely averse to the empiricist and neo-Kantian stances. In a mature science, we have no need for an "insurance" which unduly restricts our range of possible answers to new challenges. As Van Fraassen writes, "All our factual beliefs are to be given over as hostages to fortune, to the fortunes of future empirical evidence (…)"[51].

The first additional motivation of materialism becomes clear when one realizes that " matter " often works as a covering word for commitment to *objective science*. The British physicist David Cook thus quotes approvingly the following *dictum* of Lenin[52]: " (...) the sole 'property' of matter with whose recognition philosophical materialism is bound up, is the property of being an objective reality, of existing outside the mind "[53]. Lenin insisted that this broad conception of matter as "objective reality" is what enables him to meet the usual objections against materialism construed as a thesis about the existence of some "immutable substance". For, unlike the latter thesis, his materialism is not "metaphysical" but rather "dialectical" ; it is just as evolutive as science itself.

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[49] E. Schrödinger, *Nature and the Greeks,* C.U.P, 1954, p. 6
[50] B. Van Fraassen, *Quantum Mechanics, An Empiricist View,* op. cit., p. 374
[51] B. Van Fraassen, *The Empirical Stance*, op. cit. p. 63
[52] V. I. Lenin, *Materialism and Empirio-Criticism,* University of Pacific Press, 2002
[53] D. Cook, *Probability and Schrödinger's mechanics,* World Scientific, 2003, p. 6

Let's then suppose that "material" indeed means "*objective"*, and that "objective" possibly means "material". Such an equivalence is sufficient to avoid historical drifts in the semantics of the word " matter ", while everything else is "dialectically" drifting. At any period of history, physics deals with something objective, and this " something " is matter. Yet, this equivalence fails to express all the aspects of Lenin's statement (contained in "reality" and "existing"). I then propose to add a further characterization, borrowed from the discussion at the beginning of the present section :

'Something is material if it may *appear* in space-time to anybody, and if its appearances are constrained by certain clauses of *objectivity'*.

This statement is not to be considered as a closed and definitive definition of matter. We'll still have to qualify it slightly in section 5, for the sake of accommodating the case of quantum mechanics in a more satisfactory way.

At this point, we may already notice two subtle but momentous differences with traditional criteria. One does not say that a material entity *is* extended or located in space-time, but only that it may *manifest* in space-time. One does not say that it *is* an object *per se,* but that its *manifestations* are compatible with its being construed as an objective entity. In both cases, we have shifted the emphasis from transcendence to immanence.

Now what is the appropriate clause of objectivity? Characterizing objectivity as intrinsic existence is too openly metaphysical and provides us with no workable criterion. As for invoking mind-independence, this is somehow circular, since the mental and the material, the subjective and the objective domains, are not characterized independently but in mutual contrast. Van Fraassen gives several important acceptations of " objectivity " in *The Empirical Stance:* (1) " distancing ", or " taking ourselves out of the picture "; (2) substracting values, both ethical and aesthetical, from the end-product of science; (3) ignoring any aspect of phenomena that is *relative* to specific cognitive situations.

But it seems to me that the Kantian and neo-Kantian account of objectivity is more expedient and more unified. According to Kant, an object consists of a web of empirical contents connected with each other by rules which are both necessary and universal (since they are preconditions of experience). This connection is law-like; it constrains succession and coexistence of phenomena according to the three " analogies of experience ", which were strongly inspired from Newton's laws. But in a larger scientific context one may perfectly substitute other structures (especially symmetries) for laws. This is enough to cover Van Fraassen's three acceptations of objectivity at the same time : the relative aspect of phenomena is pushed aside in favor of their invariants ; value judgments are bracketed in favor of research of systematic connections ; and "taking ourselves out of the picture" occurs as a byproduct of the quest for *universal* (and therefore intersubjectively valid) rules.

Interestingly, Kant's definition of objectivity is deeply connected with space, thus making natural to identify the objects of science with material bodies. According to Kant, phenomena can be objectified, detached from particular situations, if they are pre-ordered by the concepts of our understanding in such a way that we extract invariant structures out of them. But on the other hand, these phenomena are given to us through the forms of our sensory intuition, that are *spatial*. They are bound to be spatial because space is a precondition for there being experience of things *external* to us and to each other. The only genuine objects of our knowledge are thus *material bodies*.

True, Kant does not deny phenomena of introspection, which are ordered according to the *a priori* form of the inner sense, namely *time*. He even extends tentatively the use of the word " object " to denote them: " (An empirical object) is called an *external* one if it is presented *in space*, and an *internal* object if it is presented only in a *time relation* "[54]. But this use is derivative with respect to the paradigmatic case of objects presented in space. Firstly, in his *refutation of idealism*, Kant points out that establishing a time relation " presupposes something permanent in perception ", which is " (...) possible only through a thing outside me "[55]. The order of the inner sense thus relies on some external reference. Secondly, Kant claims that due to the very nature of the phenomena it deals with, knowledge of the *psyche* can at most be a *historical* account, not a true (objective) *science*. Indeed, says Kant, the so-called objects of empirical psychology are altered and transformed by the very act of their observation[56] (a remark taken up by Bohr in his well-known comparison between psychology and Quantum Mechanics). No feature independent of the acts of observation can be extracted, no invariant can be defined (a contention against which Husserl later reacted by his concept of an experiential " essence "), and no object in the full sense of the word can thus be constituted from introspection.

The two cornerstones of Kant's theory of knowledge, namely objectification (in the sense of extracting invariants) and *appearance* in space-time, can be retained tentatively at this point. Taken together, they are the best candidate available for a criterion of materiality. Yet, as we will soon realize, this criterion is still too restrictive.

5-Matter and Experience : facing the criterion

Let us test the former demarcation line. The criterion clearly encompasses the bodies of classical physics and everyday life on the material side of the border. This was a minimal requirement; after all, the criterion was formulated for this sake. However, the status of microscopic particles is less clear-cut. To be

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[54] I. Kant, *Critique of Pure Reason* (W.S. Pluhar & P.W. Kitcher eds.), Hackett Publishing Company, 1996, A373, p. 404

[55] ibid., B275, p. 290

[56] I. Kant, *Metaphysical Foundations of Natural Science,* Bobbs Merrill, 1970, preface, AK IV, 471

sure, microscopic particles can *manifest* in space-time by impacts, bubble chamber tracks, clicks in counters etc. The new clause of manifestation in space-time is much looser than permanent location in space, and is therefore easier to apply to them. Now what about *objectivity* in a kantian sense? *Classes* (or *sorts)* of particles such as the electron, the muon, or the various species of quarks are embedded in universally valid symmetries. Their collective behaviour is law-like. But it is by no means obvious that *single* sequences of phenomena, ascribed to *one* isolated quantum, can be ordered thus[57]. Necessary connection by means of universal laws only applies to a probabilistic predictor of these phenomena, such as the state vector, but not directly to phenomena.

In this case, a decision is needed, if the extreme position according to which the object of physics might well no longer be matter at all is to be avoided. Either one wants to say that individual quantum *particles* are material after all, and this implies a softening of the requirement of law-likeness. Or one is content with the looser statement that what quantum physics describes is *matter,* while leaving open the issue of the nature of the entity that plays this role. Two plausible alternative candidate-entities are: large statistical ensembles of (putative) particles, and quantized fields. In the latter case it may be enough to combine space-time individual manifestations with *global* law-like ordering, rather than space-time individual manifestations with *individual* law-like ordering; individual spots in bubble chambers or CCD cells *and* global field equations, instead of individual spots *and* individual equations for trajectories.

To be sure, this is a considerable broadening of the definition of matter, which alters the criterion of section 4 :

'Manifestation in space-time, plus law-likeness (objectivity) applied to probabilistic predictors of classes of phenomena, is enough to characterize matter'.

Now let's have a look at the other side of the border, the non-material. To borrow an example from mathematics, a vector is non-material because, although it is embedded in the apodictic universal structure of linear algebra, it cannot manifest in space-time. A vector is objective but not manifest. Our criterion satisfactorily excludes it from the field of materiality.

Angels and ghosts offer a different illustration of non-materiality. True, they may manifest in space-time. But this manifestation is admittedly restricted to a few priviledged persons. Moreover, nobody has ever found universal laws or structures for this epiphany. I guess that nobody even *looked for* such structures, because the very idea of law-likeness would flatly contradict the super-natural or purely intentional status of these entities. The very concept of an angel or ghost is averse to the idea that their manifestations are subject to

[57] See, however, some attempts in this direction by means of the group-theoretical concept of "system of imprimitivity". C. Piron, *Foundations of Quantum Physics,* W.A. Benjamin, 1976. Discussion in E. Castellani, "Galilean particles, an example of constitution of objects", in : E. Castellani (ed.), *Interpreting Bodies*, op. cit.

law-like constraints. A ghost may manifest (to somebody), but it is not objective. Therefore it is non-material.

Finally, what about *mind?* Mind is a very interesting, but very dangerous test for our criterion, because it is a limiting case. It is even *the* limiting case *par excellence*.

At first sight, there are some reasons to enlist mind in the class of non-material entities.

Firstly, does mind appear in space-time? This is quite difficult to accept. If one states that *other* minds manifest in space-time by utterances or gestures, isn't this tantamount to say that other *bodies* manifest thus? As for one's own mind, we may be reluctant to say that it manifests *in* space-time, because it coincides with the very manifestation *of* spatio-temporal events. Mind is not a phenomenon because it is phenomenality itself.

Secondly, is mind objective? Answering " yes " without precautions yields a host of aporetical statements. Does this " yes " mean that *mind is mind-independent* (in agreement with Lenin's definition of objectivity)? Or, if one thinks of one's own mind, does it mean that subjectivity is objective? These sentences sound self-defeating.

This being granted, what can materialists mean when they construe mind as identical to, or reducible to, a material structure, or when they say that mind is a kind of software implemented on the neuronal hardware ? Taken at face value, their claim must boil down to a mere methodological decision. The heart of the materialist thesis is tantamount to deflecting any question about mental workings to questions about neurophysiological correlates. If pushed hard, most materialist philosophers usually admit that this methodological bias is essentially motivated by a contrast between the aporetical flavour of any question about conscious experience and the expanding efficiency of the neurophysiological or physical enquiry. Their choice is in favour of the dynamics of science against the quasi-statics of philosophy.

Here again, materialism shows up as a *stance*. But a stance full of false consciousness, as Van Fraassen would say, because it tends to hide what it presupposes. Indeed, the materialist claim according to which, when one studies certain aspects of the *brain* physiology, what one actually discloses is the workings of the *mind,* implicitly relies on a systematic comparison between third-person neurophysiological descriptions and first-person reports, not to mention the second person rules of mutual understanding. In order to identify a certain neurological pattern as the material basis of a certain mental state, one must use two types of approaches at once : electrodes on scalp or NMR imaging of a brain on the one side, and questions to a subject on the other side. Under the surface of an absolute hegemony of the objectifying methodology, a much broader methodology is tacitly used.

This pluralist methodology has been made explicit, and considerably developed under the name " neurophenomenology " by Francisco Varela[58]. In its mature form, it consists in enforcing *mutual constraints* between first-person statements of disciplined phenomenological contents, and third-person statements about the phenomenal invariants of behavioral and neurophysiological sciences. It is not restricted to the " view from nowhere ", but rather articulates it with situated views. Here, the objectifying method is by no means rejected, but it is seen as incomplete and embedded within a broader methodological framework.

This provides us with a good way of answering Van Fraassen's concern about the mind-body problem. According to him, if the scientific world picture is supposed to be our *entire* world picture, then "(…) we ourselves don't seem to fit into our own world picture"[59]. This is perfectly true, as long as science is restricted to a purely objectifying strategy. But if the very definition of science is so developed that it encompasses systematic articulations of third-person accounts with first-person and second-person accounts, then *We* fit again within it. *We* do not fit into a scientific world *picture*, of course, but rather in the larger methodological network of a new kind of science construed as a connecting *praxis* of every aspect of experience, be it liable to objectification or not.

Interestingly, as I have emphasized in previous work[60], Varela's broadening of the method of the science of mind can easily be generalized to become a broadening of the method of science *tout court*. If analyzed properly, Quantum Mechanics is an excellent illustration of how this new method is creeping in science. Whereas physics is usually considered the prototype of an exclusively objective science, Quantum Mechanics can hardly be understood if one ignores that it involves a thoroughgoing dialectic between invariants and situations ; between objectified structures and a network of situated (actual or potential) appearances. Here, the objectified structures are state vectors or wave functions in a Hilbert space, and the situated appearances are experimental events occurring in ordinary space-time.

In the framework of the purely objectifying strategy, there have been many remarkable and skilfull attempts at deriving the uniqueness and mutual exclusiveness of experimental events from the formalism of state vectors. But these attempts have displayed persistant loopholes. Decoherence, for instance, shows how a probabilistic structure liable to an ignorance interpretation can be derived from quantum probabilities ; yet it does not select a *single* event among the possibilities that correspond the eigenvalues of an observable. At some stage, one still needs to introduce the experienced *uniqueness* of experimental

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[58] N. Depraz, F. Varela, and P. Vermersch, *On Becoming Aware: A Pragmatics of Experiencing,* J. Benjamins, 2003

[59] B. Van Fraassen, *The Empirical Stance,* op. cit. p. 189

[60] M. Bitbol, *Physique et Philosophie de l'Esprit,* Flammarion, 2000 ; M. Bitbol, "Science as if Situation Mattered", *Phenomenology and the Cognitive Science,* 1, 181-224, 2002

events by hand, in the same way as when one imposes the "projection postulate" or when Everett writes his "memory brackets". The teaching of this half-failure is that, in quantum physics, we cannot content ourselves with a unique domain of discourse (the domain of objectified state vectors to which everything else "should" be reduced). We are faced with a persistant dialectic between two irreducible domains of discourse (objectified and situated).

Now, if the very definition of science is so broadened, if this enables (a new type of) science to deal appropriately with the mind-body problem and to make sense of some paradoxes of physics, then Van Fraassen's qualms are no longer justified. I agree with him that the sought and feared outcome of a purely objectifying procedure (his central characterization of science[61]) would be "(…) to gain the whole world and lose our own soul"[62]. But with a procedure in which objectification and systematic inquiry into first-person experience complement each other, our "soul" is regained *even within science*, with no risk of reifying it.

6-Materialism and conservatism

The example of the former section again illustrates what I see as the second motivation of materialism: *conservatism*.

There, we had a clear case of *methodological* conservatism: strict adhesion to the objectifying stance, rather than exploration of challenging alternatives such as : (a) the neurophenomenological dialectic between objective and intersubjective standpoints, or (b) an analogous reading of Quantum Mechanics in terms of a dialectic between predictive invariants and situated experimental outcomes.

But in the past, materialists also manifested strong *ontological* conservatism. Here is an expeditious historical review.

Aristotelian materialists discarded Galileo's relativity principle in view of the idea that motion should be an intrinsic property of each material substance.

Then, at the end of the seventeenth century, Cartesian neo-materialists resisted the idea of gravitational attraction at a distance, that was presented by Newton in an empiricist's style, because they considered mechanistic explanations as indispensible. True, the primary motivation of their resistance was to restore "intelligibility" in physics against Newton's alleged "occult qualities". But the actual content of their objections was to ascribe the primary role to *matter* (visible or invisible), even when *interactions* between visible material bodies are at stake. In 1733, the French physicist Privat de Molières thus criticized Newton for drawing the unwarranted conclusion that the medium which separates the planets is *not* material ; and he insisted that, although unobservable and without resistance, that medium must still be capable of

[61] B. Van Fraassen, *The Empirical Stance*, op. cit., p. 156
[62] ibid. p. 195

motion and impulsion *"as all the rest of matter"*[63]. Matter (*qua* extended stuff) was to remain the exclusive concept of physics[64]. By contrast, Maupertuis and Voltaire[65], who later advocated Newton's conceptions in France, made use of two arguments that weakened the all-pervasiveness of the concept of material body. They first pointed out that, after all, matter's "impenetrability" (which cartesians invoke) is just as unintelligible as "attraction". And they further insisted that God could well have decided to enforce laws of interaction directly, *without the mediation of "subtle" matter* moving along vortices.

In the nineteenth century, resistances against the specificity of the rising sciences of heat, electricity, magnetism, and light propagation, were similarly motivated by materialist presuppositions. At the beginning of that century, many scientists were wondering about the status of "imponderable matter" (which allegedly underpinned non-mechanical phenomena) as opposed to ordinary "ponderable matter" (which was the proper object of mechanics). A tension arose between those scientists who were ready to bracket mechanistic concepts and explicit reference to matter in order to find a general frame in which to accommodate the newly discovered phenomena, and those who wished to retain these concepts as a universal basis. On the first side, one finds e.g. Faraday, who claimed that force is a substance (and even the only substance)[66]. His views were later freed from their metaphysical undertone and endowed with their full empirical significance, by construing the field as a "system of effects" rather than as a "thing"[67]. But, at any rate, they represented a very significant challenge for material representations and ontology. On the second side of the divide, W. Thomson and the young Maxwell tried to encompass field concepts within mechanics, by way of a pseudo-material basis called the ether. A partial consensus on this issue only arose at the end of the nineteenth century, when the field-theoretical mathematics stood by itself, thus favoring the view that its mechanistic background could be considered as a helpful yet not mimetic "model". As Cassirer wrote[68], processes in ether were no longer construed as *descriptions* (of material processes), but rather as steps towards *mathematical determinations*.

At the turn of the nineteenth and twentieth century, materialists were divided between those, like Boltzmann, who supported the atomistic models of matter, and those, like the young Planck, who rather developed a mechanical model of matter as a *continuum*[69]. Both lines of thought were strongly criticized

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[63] R. Dugas, *La mécanique au XVIIe siècle*, Editions du Griffon, 1954, p. 584

[64] R. Dugas, *La mécanique au XVIIe siècle*, op. cit. p. 589 ff.

[65] ibid.

[66] N.J. Nersessian, "Faraday's Field Concept" in : D. Gooding and F. James (eds.) , *Faraday Rediscovered,* Stockton Press, 1985

[67] E. Cassirer, *Determinism and Indeterminism in Modern Physics,* Yale University Press, 1956, p. 178

[68] E. Cassirer, "Das symbolproblem und seine Stellung im System der Philosophie", *Zeischrift für Ästhetic und allgemeine Kunstwissenschaft*, I, 295-315, 1927 ; French translation in : M. de Launay (ed.), *Néokantismes et théorie de la connaissance,* Vrin, 2000, p. 217

[69] T.S. Kuhn, *Black-Body Theory and the Quantum Discontinuity,* The University of Chicago Press, 1986

by *energetists* who explicitly listed the struggle against materialism among their major motivations. W. Ostwald thus insisted that "matter is not a very felicitous notion", and that it should then be *suppressed* in favor of energy construed as an alternative continuum ; therefore, he declared, the dualism between mind and matter can be eliminated at once since matter does not exist and mind "*is"* energy[70]. No wonder, in view of the energetists's being the strongest opponents of *both* atomism *and* materialism, that the "triumph" of atomic theory[71] at the beginning of the twentieth century was hailed by many materialist thinkers as a simultaneous triumph for their belief. This meant that materialism was once again strongly connected with the good old corpuscularian view of the world.

Later on, this conviction appeared to be shaken by Quantum Mechanics[72], but then several materialist thinkers expressed concerns about the Copenhagen Interpretation of this theory and some of them advocated atomistic-like hidden variables in order to protect their doctrine[73].

And so on. This backwards-looking strategy seems to be endless.

In view of such a repetition, one suspects that conservatism is not a contingent but rather an essential characteristic of materialism. This proves quite easy to understand. In philosophy of science, materialism is a special (and rather restrictive) brand of realism. Both positions are usually associated, because materialism presents itself as belief in a certain class of entities existing out there. Now, it is crucial to any variety of realism to secure a certain historical stability for ontology. Any excess of instability would indeed trigger doubt as to whether science can ever reach (or asymptotically approach) a state where it can be said to represent faithfully the external world. As a result, a realist philosophy of science is bound to *require* ontological stability. It is part of its culture, of its basic stance, to try to *impose* an unchanging set of entities even when the theoretical landscape has been turned upside down. As R. Harré[74] rightly pointed out, according to a realist philosopher of science, it is or *should be* rational to search in nature entities which belong to a traditional type. Since these entities are likely not to be exactly identical from one stage to another of the history of science, the realist strategy imposes a "type-hierarchy" of entities which develops steadily while keeping constant some crucial features of the archetype. In the case of the materialist variety of scientific realism, the favourite type-hierarchy stems from the archetype of the material body. Some

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[70] W. Ostwald, *L'énergie,* Félix Alcan, 1910 ; quoted in : R. Dugas, *La théorie physique au sens de Boltzmann,* Editions du Griffon, 1959, p. 85

[71] J. Perrin, *Les Atomes,* Champs-Flammarion, 1991, p. 284

[72] This claim was substantiated in sections 3 and 4. Schrödinger had an especially clear awareness of it : "(…) modern atomic theory has been plunged into a crisis. There is no doubt that the simple particle theory is too naïve". E. Schrödinger, *Nature and the Greeks,* Cambridge University Press, 1954, p. 85

[73] F. Selleri is certainly one of the most brilliant advocates of this strategy. He did not content himself with defending the possibility of local hidden variables for many years. Recently, he tried to vindicate the idea of the Lorentz Ether as an absolute frame. F. Selleri, "Recovering the Lorentz Ether", *Apeiron*, 4, 246-281, 2004

[74] R . Harré, "Three Varieties of Realism", in : A.A. Derksen (ed.), *The Scientific Realism of Rom Harré,* Tilburg University Press, 1994

exceptional events in science may strongly suggest a radical change of basic entities, more rarely of "type-hierarchy" ; but, due to the dominant value of the realist stance, these events are either resisted, or minimized, or covered by "stalinesque" backward reconstruction of history.

True, a few advanced materialist philosophers of science display a remarkable aptitude to evolve, because they mostly stick to the general requirement of objectivity, and restrict their conservatism to its methodological aspect. But even their progressive attitude does not preclude some background mental reservations. Their definitions of matter usually manifest some reluctance against cutting the guiding thread that unite them to the old archetype.

Here is first M. Lockwood's elements of definition of matter : "(…) those things are material that occupy or take place in space, and whose existence is ultimately constituted by the properties and relations, actions and interactions of particles and fields, or whatever basic entities physics treats of"[75]. The last phrase states unconditional allegiance to a developing physics ; with a major qualification discussed in section 4, however : that matter could well exceed the domain of present *and* future physics, since "treating of" is not equivalent to "completely elucidating". But the beginning of the quoted definition conveys a more traditionalist flavour : *occupying* or *taking place in* space (by contrast with merely *appearing* in space, as in my own characterization), comes very close to the immemorial concept of a material body.

Similarly, J.J.C. Smart initially displays a remarkable willingness to accept the present and future developments of physics. To him, what counts as matter may be as exotic as "the less visualizable particles of modern physics", "energy", "curvature of absolute space-time"[76], etc. But this initial generosity is soon submitted to restrictive clauses. Comfort is taken from the conviction that physics will not bring us outside the domain of "space-time points", which clearly belongs to the tradition of material entities *qua* spatial. Moreover, there are limits : no genuinely *emergent* feature could ever be accepted by materialism, according to Smart. This self-imposed boundary of materialism is ironically discussed by Van Fraassen[77], who thinks, not without reasons, that it might well be shattered by future generations of materialists. But what is likely to recur, is the very need of positing boundaries, and of borrowing the conception of these boundaries from the past representations of matter.

Even the most daring modernist versions of materialism are thus counterbalanced by a touch of conservatism. This is even truer of the bulk of materialist thinkers, especially among philosophically-inclined scientists who tend to stick rigidly to the body-like type-hierarchy. They strongly resist any

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[75] M. Lockwood, *Mind, Brain and the Quantum,* op. cit. p. 20
[76] J.J.C. Smart, "Materialism", loc. cit.
[77] B. Van Fraassen, *The empirical Stance,* op. cit. p. 56-57

change, when (like J. Bricmont[78]) they adopt hidden variable strategies. They (sometimes intentionally) reconstruct history, when they say that there is much in common between J.J. Thompson corpuscular electrons and the modern electron construed, after Wigner, as "a state of the quantum field that transforms under elements of the Poincaré group according to a definite irreducible representation"[79]. They minimize changes when they accept without the slighest doubt that what physics studies is still "matter", despite the extreme distance between the objects of microphysics and the archetype of the material body ; and also despite the growing consensus, derived from decoherence, that material bodies at our scale should *itself* be construed as an emergent *appearance* out of some sort of dispositional background (to the great disarray of followers of J.J.C. Smart, who would be torn apart between their materialist dislike of emergence and the emergent status of material body-like appearances according to decoherent quantum mechanics !). Finally, many of these materialist thinkers impose themselves the recurring concern of solving the well-known "paradoxes" that arise when the measurement process is described within the framework of an ontology of little chunks of stuff (irrespective of the growing flexibility in the way these material elements are said to behave, and except, of course, in the framework of hidden variable theories).

This is another set of reasons why I tend to be much less "tolerant" than Van Fraassen of the particulate model of matter : this model embodies the many-faceted conservatism which is so typical of materialism. The particulate model may still be acceptable to a certain extent. But, in the same sense as a theory can be "regressive" at a certain stage of history according to Lakatos, the trans-theoretical particulate model is clearly *regressive* at the present stage of history. As we saw in sections 3 and 4, it can adapt only by relying on a list of qualifications which both transforms it beyond recognition and is open-ended with no limits in sight.

By contrast with this conservative attitude, an empiricist philosopher of science (and a neo-Kantian philosopher as well) should not shy away from claiming that her stance is superior to the materialist stance with regard to a meta-value that both empiricists and materialists cherish : the belief in (some sort of) progress in science, and the open-mindedness to revolutionary changes in representations able to promote this progress. To illustrate this, let us consider a full-blown empiricist or neo-Kantian view of Quantum Mechanics. According to it, this theory essentially consists of a deviant probabilistic formalism bearing on experimental events, with no need of any remnant of the materialist ontological hierarchy-type. This view thereby provides us with a *dissolution* rather than a solution of the measurement problem, since the state vectors (that are subject to the superposition principle) no longer represent "states" of more or

[78] A. Sokal and J. Bricmont, *Intellectual Impostures,* Profile Books, 1998

[79] G. Peruzzi, "Microphysical Objects and Experimental Evidence", in : E. Castellani, (ed.), *Interpreting Bodies,* Princeton University Press, 1998

less body-like systems. They only provide us with an appropriate algorithm for probability valuations whenever contextual phenomena are concerned[80]. With respect to this strict economy, Van Fraassen's version of the modal interpretation of Quantum Mechanics adds a formalized strict separation between events consisting in some observable's having a value on the one hand, and (dynamical) states that serve to calculate the probabilites of these events on the other hand.

Clearly, empiricist and neo-Kantian views underdetermine the concepts and representations that can be added to this bare probabilistic skeleton in order to get a picture of the world agreeing with Quantum Mechanics. They tend to be *pluralist,* with no claim to exhaustivity, with respect to pictures one may tentatively associate with theories[81]. And they remain completely open to future options able to revolutionize every single element of our tentative picture(s) of the world. Accordingly, these alternative stances are associated with a "progressive" attitude (in Lakatos's sense) when guiding representations are concerned. They tend to favor radically new representations over traditional types, as soon as it becomes clear that these representations bring more coherence and more unifying power in the current state of science ; or, in neo-Kantian terms, that they expand the domain of objectification so that it comes closer to universality.

7-Conclusive remarks : On Constructive Empiricism and Transcendental Epistemology

In the former sections, I assumed that (constructive) Empiricism and neo-Kantianism would often side together in the controversy about materialism. This is not surprising from a historical standpoint, since, after all, Kant's critique of dogmatic metaphysics was explicitly derived from Hume's devastating *tabula rasa*. However, the two groups of thinkers are likely to part company at some point. A symptom of this was my growing reluctance about what I consider an excessive indulgence of Van Fraassen's empiricism for the particulate model of matter which is spontaneously favored by materialist thinkers. So, in this last section, I will recapitulate and further develop the reasons why this major difference in appreciation about the particulate model of matter is bound to occur.

To begin with, let me state why neo-Kantian philosophers of science have any motive to discard this model. In the process of their intellectual transformation at the turn of the nineteenth and twentieth century, they

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[80] "What is the solution to the measurement problem ? I say it is this : on measurement of X with eigenstates $|x_i>$ outcome x_i is observed with probability $|<\psi|x_i>|^2$, where $|\psi>$ is the initial state. This is what we return to, so it will do for a beginning as well" S . Saunders, "Time and Quantum Mechanics", in : M. Bitbol & E. Ruhnau, *Time, Now and Quantum Mechanics,* Editions Frontières, 1994.

[81] B. Van Fraassen, *Quantum Mechanics, An Empiricist View,* Oxford University Press, 1991, p. 337

completely relinquished the rigidity of Kant's *a priori* forms of thought which underpin the ontological type of material body, and rather adopted Cassirer's conception of historically drifting and relativized *a priori*. In Cassirer's *Philosophy of Symbolic Forms*[82], the world is shaped in advance, or endowed with meaning, according to the successive states of our forms of life and collective interests expressed by culture. Even though previous states of the structuring *Symbolic Forms* may persist within the present culture, they must be recognized as such (i.e. as residual) in order to be defused, and in order to allow full development of the latest state. This did not prevent Cassirer from becoming one of the most emblematic supporters of pluralism, of a plurality of "worlds" according to the plurality of the formative symbols[83]. Cassirer was even prone to accommodate an exceptionally large range of organizing principles, since he did not restrict the scope of his symbols to various scientific theories, but rather accepted myth and art as alternative possibilities of objectifying according to different lines of interest. However, as soon as a given line of collective interest has been chosen, one must be attentive not to concede too much to alternative lines, especially if this means mixing them up unselfconsciously.

One crucial example, documented by Cassirer, is the transition between the *representational* symbolic meaning and the *significative* symbolic meaning (between *Darstellung* and *Bedeutung*). Representation develops in sense perception and is stabilized by everyday language ; it cristallizes into the standard metaphysical pattern which consists in distinguishing between enduring bodily substances (referred to by means of nouns) and their variable properties (denoted by adjectives). This is a major source of the materialist archetype. But mathematics and physics inaugurated an entirely new class of ("significative") symbolic meaning which rely on the category of relation. There, the category of substance is no longer needed to organize appearances around stable nuclei ; it is *replaced* with "functional" connections, structures, and laws that connect systematically the appearances in flux to one another. Although Cassirer first elaborated these ideas by thinking about nineteenth century classical physics, he soon realized that Relativistic Physics and Quantum Mechanics provided him with an even more striking illustration of this transition from (body-like) entities to relational networks. Now, as I have just suggested previously, according to Cassirer, one must integrally *substitute* the new Symbolic Form for the old one, if full coherence is to be reached. A major problem is that both of them are in fact present in different *strata* of our present culture, and that they (and their corresponding *strata*) prove very difficult to reconcile. The old Symbolic Form which gave meaning to the substantial concept of material body is still there,

[82] E. Cassirer, *Philosophy of Symbolic Forms : The Phenomenology of Knowledge,* Yale University Press, 1957. For an empathic and broad-ranging reconstruction of Cassirer's views on physics, see : C. Schmitz-Rigal, *Die Kunst Offenen Wissens : Ernst Cassirers Epistemologie und Deutung der modernen Physik*, Meiner Verlag, 2002. My understanding of the permanent value of Cassirer's epistemology for contemporary science owes a lot to Christiane Schmitz-Rigal and the many friendly discussions we have.

[83] N. Goodman, *Ways of Worldmaking,* op. cit. p. 1

since it is needed as a polyvalent tool of communication able connect culture as a whole with some aspects of the scientific enquiry. But if taken at face value *within the scientific line of interest,* it tends to hinder the full development of the new (functional) Symbolic Form of mathematical physics by instillating germs of artificial paradoxes. This is the reason why Cassirer and his followers tended to cut the materialist ontological hierarchy-type at its root within the domain of science, instead of being inclined to conciliation.

A good exemple of this uncompromising spirit can be found in Cassirer's book on Quantum Mechanics : "(…) what *are* these electrons whose path we can no longer follow ? Is there any sense in ascribing to them a definite, strictly determined *existence*, which, however, is only incompletely accessible to us ? Or must we not take the opposite path – must we not take seriously the demand that we use the conditions of the possibility of experience – that is, the conditions of accessibility as conditions of the objects of experience ?"[84]. The latter sentence clearly refers to Kant's "supreme principle" in the *Critique of Pure Reason* : "(…) that the conditions of the possibility of experience are simultaneously conditions for the possibility of *objects* of experience (…)"[85]. Objects are shaped, defined, or *constituted* by these conditions of accessibility ; they are not pre-existing things incompletely revealed by imperfect access. Cassirer's conclusion is that, if the instrumental accessibility conditions (elaborated according to a plan that fully takes into account the interest of scientific knowledge) are such that they let emerge structural patterns that generally do *not* coincide with the representational archetype of language, then the latter must be dispensed with straightaway. Remnants of this archetype (such as "electrons" in the sense of particular spatio-temporal continuants) should accordingly be *denied any existence*.

Keeping this conception in mind, I will now try to identify the central motive a major empiricist thinker such as Bas Van Fraassen has to remain neutral with respect to the particulate conception of matter. In a few words, this motive is that a constructive empiricist construes the influence of our conceptual scheme on the "factual" material in a *less radical* way than neo-Kantianism. True, in his last book, Van Fraassen developped a devastating criticism of "fundamentalism" in epistemology, and insisted that the classical empiricist slogan "*sola experientia*"[86] is to be qualified with interpretation and theory-ladenness. Furthermore, in an earlier book, he openly stated that science relies on a "hermeneutic circle"[87]. However, in spite of this, Van Fraassen still uses expressions which irresistibly suggest that he believes in a sort of *An Sich* nucleus of phenomena. This is the case, e.g., when he writes in *The Empirical Stance* : "The phenomena (how nature has appeared to us so far) admitted of

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[84] E. Cassirer, *Determinism and Indeterminism in Modern Physics,* op. cit. p. 178
[85] I. Kant, *Critique of Pure Reason,* B197, Hackett Publishing Company, 1996, p. 228
[86] B. Van Fraassen, *The Empirical Stance,* op. cit. p. 119
[87] B. Van Fraassen, *The Scientific Image,* op. cit. p. 56

being classified as the appearances of Newtonian systems. Newton was wrong only in thinking that the interpretation was unique". And a few lines below : "So, science, like art, interprets the phenomena, and not in a uniquely compelled way"[88]. The quoted sentences sound as if there were bare phenomena at first, and (theoretical) interpretation secondarily. This impression is reinforced when we realize that, according to Van Fraassen, the distinction between what is "observable" and what is "inobservable" does not depend on a theoretical intepretation[89]. The initial remark that empirical "data" cannot even be disentangled from a preliminary interpretation then seems to have faded away (or at least to have met certain limits).

I think the explanation of this apparent tension is that, when Van Fraassen refers to "interpretation", this term is restricted to explicit theoretical "seeing as". The pre-theoretical "symbolic" *strata*, especially those connected with perception and language, are not construed as interpretative conditions, but deliberately taken for granted. Thus, in *The Scientific Image*, the "hermeneutic circle" is stopped as soon as it comes close to ordinary observation : "I regard what is observable as a theory-independent question. It is a function of facts about us *qua* organisms in the world (…)"[90]. This is what enables one to establish a cut between pre-interpretational phenomena, that depend (say) on our perceptive-biological constitution, and an interpretational process which comes later and relies on highly elaborated theories. Of course, one may object (as Van Fraassen himself does after the quoted sentence) that our perceptive-biological structure is itself apprehended through a theoretical representation, and that this only adds one more layer of interpretation. But an answer to this objection is available. It consists in pointing out that there exists a *de facto* limitation to our *hybris* of universal theorizing as it manifests itself in the project of all-encompassing *Naturalization*. The limitation, says Van Fraassen, is that we start our investigation *somewhere* : "(…)Like Neurath's mariners at sea, we are historically situated. We rely and must rely on our pre-understanding, our language (…)"[91].

A neo-Kantian philosopher is bound to approve this substitution of epistemic pre-conditions for unqualified naturalization of epistemology. Van Fraassen even cogently points out, here again in very good agreement with the neo-Kantian strategy, that "Rationality will consist not in having a specially good starting point but in how well we criticize, amend, and update our given

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[88] B. Van Fraassen, *The Empirical Stance,* op. cit. p. 149. I thank I. Peschard for having attracted my attention on the latent meaning of these sentences, by a thorough and cogent analysis. I. Peschard, *La réalité sans représentation,* op. cit., p. 80

[89] B. Van Fraassen, "From vicious circle to infinite regress and back again", in : D. Hull, M. Forbes, and K. Okruhlick, (eds.), *Proceedings of the 1992 biennial meeting of the Philosophy of Science Association*, vol 2, 1993 (in *Philosophy of Science*)

[90] B. Van Fraassen, *The Scientific Image,* op. cit. p. 58

[91] B. Van Fraassen, *The Empirical Stance,* op. cit. p. 139

condition"[92]. This is remarkably close to the spirit of a *Critique of Pure Reason,* provided Kant's absolute *a priori* are replaced by a relativized *a priori* liable to updating. But here arises a major point of disagreement, which bears on the intensity and scope of the criticism. A neo-Kantian philosopher of science (whose model is Cassirer) would say that criticizing our "given condition" can mean nothing less than considering it as a hidden source of *interpretation*. This implies a generalization of the hermeneutic circle. A generalization Van Fraassen attempted to avoid in chapter 3 §7 of *The Scientific Image,* because he wished to protect us from the threat of infinite regress or vicious circularity. By contrast, according to neo-Kantianism, there is no infinite regress or vicious circularity to be feared, provided one accepts that, *in practice,* there is a contingent (possibly drifting) historical boundary to this *in principle* endless hermeneutic process. Neo-Kantianism accepts Van Fraassen's Neurathian starting point, but wishes to avoid any absolutization of it. As a consequence, a neo-Kantian philosopher has no reason to balk at generalizing the role of interpretation throughout the process of knowledge.

Once this generalization is granted, the realm of macroscopic observables completely changes its status. It can no longer be treated as something resistant (let alone "intrinsically real") offered to theoretical interpretation, but rather as the by-product of a deeper *stratum* of interpretation. It is just as much dependent on interpretation as the realm of theoretical entities is, although not at the same stage of the piling up of hermeneutic circles. Having lost any priviledge, the domain of macroscopic observable objects and properties, with its logico-linguistic structure of substance and predicate, is no longer automatically acceptable as a paradigm for tentative ontologies in physics. No step by step extrapolation from the macro-domain to the micro-domain is seen as unavoidable.

We can now better understand why Constructive Empiricism tends to be indulgent towards the attempt at building ontologies (such as the particulate one) by extrapolating from the archetype of macroscopic observable bodies : most likely because this archetype coincides with the *de-facto*-absolute starting point of Constructive Empiricism itself. By contrast, neo-Kantianism is bound to be very critical against the latter ontological attempt. Indeed, the neo-Kantian *stance* consists in submitting *all* the archetypes to a hermeneutic approach, and looking for the best interpretive strategy available at each stage of the historical development of knowledge.

When even the smallest remnant of foundationalism is missing, materialism is automatically deprived of its ground.

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[92] ibid.