To appear in *Journal for General Philosophy of Science* (2004)

In Defence of Constructive Empiricism: Metaphysics versus Science

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August 2003

Summary

Over the past years, in books and journals (this journal included), N. Maxwell launched a ferocious attack on B.C. van Fraassen's view of science called *Constructive Empiricism* (CE). This attack has been totally ignored. Must we conclude from this silence that no defence is possible against the attack and that *a fortiori* Maxwell has buried CE once and for all, or is the attack too obviously flawed as not to merit exposure? We believe that neither is the case and hope that a careful dissection of Maxwell's reasoning will make this clear. This dissection includes an analysis of Maxwell's 'aberrance-argument' (omnipresent in his many writings) for the contentious claim that *science implicitly and permanently accepts a substantial, metaphysical thesis about the universe*. This claim generally has been ignored too, for more than a quarter of a century. Our conclusions will be that, first, Maxwell's attacks on CE can be beaten off; secondly, his 'aberrance-arguments' do not establish what Maxwell believes they establish; but, thirdly, we can draw a number of valuable lessons from these attacks about the nature of science and of the libertarian nature of CE.

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1 Exordium: What is Maxwell's Argument?

The Argument. Building on work dating from the early 1970s, N. Maxwell has expounded, in a sequence of papers and in books, a metaphysical-realist conception of science awkwardly named 'Aim-Oriented Empiricism'.[1] Logically prior to the exposition and defence of his novel conception of science, Maxwell claims to have "decisive grounds" for rejecting a conception of science called 'Standard Empiricism', of which Van Fraassen's 'Constructive Empiricism' is purportedly a version; thereby the need is created for a novel conception (Aim-Oriented Empiricism, then, is supposed to satisfy this need).[2] The sole purpose of the present paper is to analyse Maxwell's "decisive" argument *against* Constructive Empiricism (henceforth: *the Argument*); part and parcel of his Argument is his 'aberrance-argument' for the claim that science permanently makes a substantial metaphysical assumption about the nature of the universe.[3]

We begin with a definition of a view of science called

> **Standard Empiricism (SE).** (SE1) *Science*[4] *does not accept any permanent, substantial, metaphysical assumptions about the universe (independent of the evidence and certainly never in violation of the evidence); and* (SE2) *the decision to accept or reject a scientific theory is based exclusively on the available evidence.* (1)

Presumably SE2 entails SE1, although that will depend on what is meant by 'metaphysical'; until further notice we shall keep both SE1 and SE2 for ease of reference and take them to be a jointly exhaustive characterisation of SE. The global logical structure of Maxwell's Argument against Standard and Constructive Empiricism is as follows.[5]

P1 **Maxwell's Thesis.** *Science permanently accepts a substantial, metaphysical thesis about the nature of the universe.*

C1 Science contradicts Standard Empiricism — from P1 and SE1.

P2 Constructive Empiricism is a version of Standard Empiricism, *i.e.* it meets both conditions SE1 and SE2 of SE (1).

C2 Science also contradicts Constructive Empiricism — from C1 and P2.

[1] Maxwell (1974), (1993), (1998), (2002).

[2] Maxwell (1993: 61, 81), (1998: 36-38), (2002: 3-5); for Constructive Empiricism, see Fraassen (1980), (1989).

[3] Since the Argument motivates Maxwell's own view of science and therefore is logically prior to it, we can and shall ignore Maxwell's 'aim-oriented-empiricism'. See Smart (2000) and Muller (2003) for reviews of Maxwell (1998).

[4] For the sake of brevity, by 'science' we mean in the Argument 'the (overwhelming majority of the) scientific community' unless specifically stated otherwise.

[5] Maxwell (1974: 131), (1993: 65, 68-69, 78), (1998: 46-54), (2002: 3-5).

C3 Standard Empiricism must be rejected — from C1 —, and then, by virtue of C2, Constructive Empiricism must also be rejected.

Preliminary Comments. The following comments provide us with the opportunity to give a preview of the present paper.

(i) A warning is in order: Maxwell's wording of SE and other theses and notions can differ subtly from one publication to another. We start with the most simple and straightforward wordings and analyse his arguments with these wordings; as we proceed, other wordings will be considered and the bearing of these other wordings on the Argument and our analyses will be investigated (specifically in Sections 3.3 and 3.5). For reasons of exposition it has turned out best to begin with SE as it stands (1).

(ii) We shall assume that throughout the Argument 'acceptance' is used in Van Fraassen's pragmatic sense of acceptance *simpliciter*. Acceptance is, then, taken to be the mental state guiding our behaviour and is (supposed to be) devoid of any overtly epistemic connotations, such as when we consider an accepted proposition to be part of *scientific knowledge* or believing it to be *true* (although for Van Fraassen, acceptance admittedly has epistemic implications; cf. Section 3.1).[6] We *must* proceed in this fashion in order not to let Maxwell *ab ovo* commit the fallacy of equivocation with respect to (Van Fraassen's notion of) acceptance. In Section 3.5, we briefly explore four other notions of 'acceptance', some of which *are* overtly epistemic.

(iii) Notice that logically speaking only SE1 of SE (1) is needed in the Argument, which implies that criticisms restricted to SE2 (1) are doomed. Maxwell (1993: 65) located SE2, for instance, in K.R. Popper's *Conjectures and Refutations*.[7]

(iv) Logic *alone* does not dictate anyone to reject any form of empiricism when it contradicts science (C1, C2), so *more* than logic is required to vindicate the final step of the Argument (C3); we shall see, however, that the nature of the contradiction is such that we shall unhesitatingly rule in favour of science to save us from the putative inconsistency.

(v) In general, a conclusion cannot be more convincing than any of its premises. In case of the Argument, these are premises P1 (Maxwell's Thesis) and P2; both of them obviously stand in need of argument in order to produce a convincing Argument. Premise P1 seems to say nothing less than that every scientists is a metaphysical realist of sorts!

Preview. In Section 2, we analyse Maxwell's reasoning in favour of *Maxwell's Thesis*, which is premise P1 of the Argument, and judge it unconvincing. We claim that in

[6] We call a declarative sentence a *statement*, and classes of logically equivalent statements *propositions*. We shall confuse 'statement' and 'proposition' on a regular basis and we apologise for that in advance.

[7] Popper (1963: 54): "*the principle of empiricism* which asserst that in science, only observation and experiment may decide upon the *acceptance* and *rejection* of scientific statements, including laws and theories." Popper considers replacing this principle with some 'metaphysical principle' and says about this: "I have never seen any formulation which even looked promising or was not clearly untenable." (*ibid.*) Cf. Maxwell (1998: 2-3, 38-45) on the topic of how widely SE is held.

Maxwell's writings two distinct 'aberrance-arguments' in favour of premise P1 can be discerned; the first is an abductive argument, the second a deductive argument.[8] In Section 3, we argue that Constructive Empiricism (CE) is, properly conceived, *not* a version of SE, which means we must reject premise P2. Thus our conclusion will be that Maxwell's attack against CE fails. Briefly, Section 2 is devoted to premise P1 and Section 3 to premise P2 of the Argument. In Section 4, we present the results of our analyses and the lessons we have learned along the way. These lessons show that Maxwell's attack has not been in vain but has taught us a thing or four about science and CE.

2 Does Science Implicitly Accept Metaphysics?

In this Section we analyse the two aberrance-arguments in favour of (P1) Maxwell's Thesis. Below we shall proceed by collecting step-wise the premises of the two aberrance-arguments we have discerned so as to reach a position where we can assess them.

2.1 Aberrant Theories

Although the aberrance-argument is supposed to apply to science generally, we restrict ourselves to physics, as Maxwell does. We first explain the concept of an 'aberrant version' of a scientific theory.[9]

Consider Newton's theory of universal Gravitation (NG). Consider a so-called *aberrant* version of it which says exactly the same as NG save for golden spheres having a radius of exactly 13 km, for which a different law of gravitation is postulated, saying that the gravitational force is repulsive (NG1), or varies with the inverse-cube of the distance between the spheres (NG2). Consider a version of NG which is different from NG only in that r^{-2} in Newton's law of gravitation is replaced with $r^{-(2+\varepsilon)}$, where ε is an extremely small positive number, say a power of 10 such that $\log \varepsilon = -10^{100}$ (NG3). A Humean

[8] *Personal comment.* Maxwell prefers a rough style of arguing and does not prefer to use jargon. Sometimes I have the impression that Maxwell's prose exhales disdain for an unambiguous, precise statement of the premises and the conclusion of an argument, for a careful preliminary discussion of the concepts involved so as to reach an appreciable level of clarity about their meanings, and for a step-wise explication of the reasoning saying in each step which premise is used and how. Let me hasten to add that this is not true of Maxwell's work generally, because he is the only extant philosopher of science who has tried to define what the 'simplicity' of a scientific theory resides in, in terms of *what* the theory says about the world rather than *how* it is being said; see (1998: 51-54, 104-109). But when it comes to his aberrance-argument, this is true: in trying to understand this argument precisely, I felt more like being on a fishing expedition rather than reading an argument of a philosopher who had done his homework.

[9] All accepted scientific theories are not aberrant. Although Maxwell makes an exception for quantum mechanics (1998: 228-229), we joint him in ignoring this when considering the aberrance-argument.

nightmare version of NG is NG but in the year 3,000 A.D. the gravitational force will disappear completely in the entire universe (NG4); then some day in that year the sun will not rise tomorrow. Next we have a theory that postulates *two* universal forces between every two bodies, an *attractive* 'gavitational force', which is twice as strong as the gravitational force of NG, and a *repulsive* 'ravitational force', which has the same strength as the gravitational force (NG5); so whenever we consider two bodies in accordance to NG5, we always have the sum of the gavitational and the ravitational force (for convenience contracted to 'gravitational force'). We also have a version of NG that says the same as NG but for a spatio-temporal region whose spatial part has the size of a marble and whose temporal part is about 1 nanosecond; in this region, located in the Andromeda Nebula during Easter 37 A.D., there is no gravity (NG6). Finally we have a theory like NG but for a two-body system like the Sun and Mercury it postulates a precession of its perihelia which is in exact agreement with observations (NG7).[10] Notice that NG1-NG4 almost certainly are *empirically false* (*i.e.* do not save all the relevant phenomena), although we shall never be absolutely certain about it; NG5 is empirically equivalent to (but ontologically distinct from) NG; NG6 is almost empirically equivalent to NG; and NG7 is empirically more successful than NG because NG7 saves at least one more phenomenon than NG does.

We can go on like this endlessly. We can play this aberrance game with every single accepted physical theory. David Hume can be seen as the first player; Nelson Goodman, with his grue-bleen moves, is another famous player; Maxwell boasts of being a contemporary player.[11] The imagination is the limit and that is no limit at all. For want of a name, we call *regular* all non-aberrant theories, such as NG, classical mechanics, classical electrodynamics, the special theory of relativity, *etc.*, *i.e.* such as all actually accepted theories.[12] For those who worry about theories of which it is not easy to say whether they are aberrant or regular: do not worry, everything asserted in this paper goes through if you take for 'aberrant' theories only the *utterly bizarre* ones (there is an infinitude of them too and *this* is sufficient to get the aberrance-argument going).

Maxwell's aberrance-arguments in favour of premise P1, *Maxwell's Thesis*, can be found

[10] Cf. Maxwell (1993: 68-70), (1998: 51-55).

[11] Maxwell (1974: 128-131), (1993: 67-69, 89), (1998: 47-54), (2002: 3-5).

[12] For further discussion of the distinction regular/aberrant, including a *more-or-less precise definition*, and of why aberrant theories have to be taken seriously (Hume, Goodman and their commentators did), we refer to Maxwell (1998: 47-56) and Kukla (2001). The very fact that a more-or-less precise definition of 'aberrant' can be given removes a worry that may have arisen, namely that of the explanation of 'an aberrant version of' were to rely on a *regular* theory being given first, this would make the explanation circular because 'regular' is supposed to mean 'not aberrant'. The reasons why we have explained 'abberancy' by means of presenting examples are pedagogical and spatio-temporal — Maxwell's definition (*ibid.*) is rather elaborate.

in various places.[13] Indulge us one quotation in full from the present journal:

> But now comes the decisive point. In persistently rejecting infinitely many such empirically successful but grotesquely *ad hoc* [= aberrant, FAM] theories, science in effect makes a big permanent assumption about the nature of the universe, to the effect that it is such that no grotesquely *ad hoc* theory is true, however empirically successful it may appear to be for a time. Without such a big assumption as this, the empirical method of science collapses. Science is drowned in an infinite ocean of empirically successful *ad hoc* theories.[14]

We begin our analysis of the first aberrance-argument by reporting the undeniable fact that science only accepts regular theories and dismisses aberrant (utterly bizarre) theories without a moment's thought; aberrant theories rarely if ever enter the scientific competition of acceptance and rejection; they seem a typical product of the philosophical imagination run wild. Therefore the first premise of the aberrance-argument is an undeniable truth:

Ab. *Science rejects all aberrant theories and accepts only regular theories.* (2)

For the sake of future reference, we also formulate the following two theses:

U. *The universe is comprehensible, which by definition means that it is such that it makes all aberrant theories false.*[15] (3)

And

EmpU. *The universe is empirically comprehensible, which by definition means that it is such that it makes all aberrant theories empirically false, or synonymously empirically inadequate, which is to say that the universe is such that no aberrant theory saves all the phenomena it is supposed to save.* (4)

Obviously **U** implies **EmpU** but not conversely. Entertaining or accepting or considering any of these theses presupposes it makes sense to utter expressions like 'the universe *is* such that ...', 'the universe is constituted in a certain way' and sibling expressions; to emphasise, judging such expressions to be *meaningful* does not presuppose that (one has to believe that) they are *true* (or *false* or neither).

[13] Maxwell (1974: 128-131), (1993: 67-78), (1998: 47-64).

[14] Maxwell (2002: 4-5).

[15] No claim is being made that the definition of 'comprehensible' is in *full* agreement with everyday use; we need a name for the predicate described in **U** and we have chosen 'comprehensible' because Maxwell has chosen it. Notice that **U** is what Maxwell asserts in the displayed quotation above: "no grotesquely *ad hoc* theory is true".

Both theses **U** and **EmpU** talk about 'falsehood'. About the concept of truth we should assume as little as possible. Let us assume no more than this:

> **Truth.** *Scientific theory T is true iff the universe is such that it is like T says it is; and T is false iff the universe is unlike T says it is.* (5)

It seems that this is exactly what we *mean* when we say that *T is true* — although one need not accept *this* additional explicatory gloss put on **Truth** in order to accept **Truth** (5). Rather than 'true', one could say 'ontologically adequate', because **Truth** (5), just like thesis **U** (3) and **EmpU** (4), presupposes it is *meaningful* to utter expressions like 'the universe *is* such that ...', *etc.*[16]

2.2 Only Methodological Assumptions?

To find out whether science (implicitly) accepts some thesis, one could, it seems, simply ask a representative sample of scientists whether they accept the thesis or not. But when it is some *metaphysical* thesis, a poll will not work, Maxwell submits, because scientists are brain-washed with SE (1), the 'official ideology of science'; they will deny they accept any metaphysical thesis about the universe (SE1).[17] Scientists believe — falsely according to Maxwell (1974: 126) — that criticising SE is an act of scientific betrayal. Until further notice we shall not challenge Maxwell's problematic charge of all scientists suffering from a 'false consciousness' (perhaps Oprah Winfrey should have a long talk with our scientists, pronouncing her immortal words: 'Denial is *not* a river in Egypt.'). We propose to get around the problem in the only way conceivable: by explictily *postulating* a certain connexion between the observable behaviour of scientists, as reported in **Ab** (2), and unobservable assumption-making of scientists in their minds, because this is what Maxwell is surreptitiously doing. First we write down this postulate; then we explain it.

> **Acc.** *IF someone follows method $\mathcal{M}$ to reach aim $\mathcal{A}$, and expects that following this method will help him considerably in reaching aim $\mathcal{A}$, THEN he accepts the concomitant methodological assumption* $\mathbf{U}[\mathcal{M}, \mathcal{A}]$*, which asserts that the universe is such that following method $\mathcal{M}$ is of considerable help in reaching $\mathcal{A}$.* (6)

Surely it is not straightforward to read off which assumptions Albert, say, is making from the methods he follows, for distinct assumptions may lead to exactly the same behaviour. In the light of rampant Duhem-Quine indeterminacy (which parenthetically

[16] Those who hold that only a theory plus an ontology can tell us what the universe is like, rather than a 'bare theory', can take '*T*' to stand for '*T* dressed with some ontology'. Such a change will not affect the arguments in this paper in any significant sense.

[17] Maxwell (1974: 126), (1998: 41-43), (2002: 24). Whether all scientists actually subscribe to SE (1) is for us an open question. Not an open question for us is whether there is a living philosopher of science who defends SE2 (1) — there isn't any.

militates heavily against SE), on could even turn the tables and defend the opposite: observable behaviour does *not* determine what goes on in the head. Nonetheless there are cases and circumstances where this can be done *beyond reasonable doubt*. For example, consider Albert throwing water in the waste-paper basket besides his desk which has caught fire because in a moment of absent-mindedness he threw in it what was left of a tasty Cuban cigar. Can we infer from his behaviour that Albert accepts the *Assumption* that the universe is such that water extinguishes fire? Presumably we can. But now suppose there happened to be standing an oil-can next to a bucket filled with water. Suppose further that Albert (whose ignorance about mundance matters is legendary) later declares he did not have clue whether oil or water extinguishes fire, or both, or neither, and that it was sheer luck that he chose to empty the bucket of water on the burning waste-paper basket. In this case the ascription of the *Assumption* to Albert is wrong after all. But if Albert tells us he *expected* to be successful with water and adds, with raised eyebrows, that *of course* he would have made the situation much worse if he had thrown oil on the flames instead, then the inference to Albert making the *Assumption* is wholly correct.

So it seems that, to generalise cautiously, if someone applies method $\mathcal{M}$ to achieve aim $\mathcal{A}$, *and expects* that applying method $\mathcal{M}$ will considerably help to achieve aim $\mathcal{A}$ (if not guarantee success), *then* he accepts what we shall call the *methodological assumption* $\mathbf{U}[\mathcal{M}, \mathcal{A}]$ of method $\mathcal{M}$ given aim $\mathcal{A}$: *the universe is such that applying method $\mathcal{M}$ helps to achieve aim $\mathcal{A}$*; the height of someone's expectations is a measure of how confident he is in accepting $\mathbf{U}[\mathcal{M}, \mathcal{A}]$.[18] Well, this is precisely assumption **Acc** (6). But now the problem is: how do we know what someone *expects*? We can observe whether someone applies a method, or goes against it, but we cannot observe what his expectations are. They are in his mind. Duhem-Quine indeterminacy strikes again. Someone may apply a method without cherishing any expectations about its outcome whatsoever (as we have seen in the example with Albert); in that case no assumptions about the universe are made. In such a case one often speaks of a 'working-hypothesis'. What we need is some connexion between observable behaviour and unobservable expectations.

Consider the following methodological rule (Maxwell's example):

> $\mathcal{R}$. If a theory does not explicitly assume that all matter consists of *atoms* (in the etymological sense) and it does not describe how matter interacts by means of contact forces alone, then reject the theory. (7)

[18] Cf. Maxwell (1998: 10). Notice that every assumption, metaphysical or not, that can be the basis of a rule of how to achieve a particular aim is a *methodological* assumption. To say that methodological assumptons are not metaphysical is to utter a falsehood.

The concomitant methodological assumption is as follows:

> **U**$[\mathcal{R}, \mathcal{A}]$. Matter is not infinitely divisible, but consists of building blocks that cannot be divided further (the atoms), and that pieces of matter, atoms included, influence other pieces of matter only by means of *contact forces*, *i.e.* only when they touch each other. (8)

Here aim $\mathcal{A}$ is the epistemic aim of science and it matters little what one takes $\mathcal{A}$ to be: ontological adequacy (truth), empirical adequacy (empirical truth), explanatory adequacy, and what have you. Now *suppose* that all physicists apply rule $\mathcal{R}$ (7) scrupulously, time and again, without exception, so that theories assuming the infinite divisibility of matter, theories that operate with action-at-a-distance or with fields, and what theories have you, are all rejected flat out of hand by the scientific community, and that only atomistic-mechanistic theories are taken seriously. In *this* supposed situation we need not inquire whether physicists have higher expectations to be successful when applying rule $\mathcal{R}$ (7) than when they break it (no matter how one construes the aim of physics); it is *evident that they do*. Actions speak louder than words. Methodological assumption **U**$[\mathcal{R}, \mathcal{A}]$ (8) surely is accepted. This is no different than when we infer from the observable behaviour of firefighters when there is a fire that they accept the assumption that the universe is such that throwing water on fires extinguishes them. So let us lay down the following general premise:

> **Exp**. *IF someone always follows method $\mathcal{M}$, and never goes against $\mathcal{M}$ although nothing prevents him from doing so, THEN he has higher expectations to be successful when following $\mathcal{M}$ than when going against $\mathcal{M}$.* (9)

Assumption **Exp** (9) postulates a plausible connexion between recurring observable behaviour and unobservable expectations. **Exp** applied to the supposed behaviour of the scientific community sketched above leads to the conclusion that the community accepts an atomistic-mechanistic ontology **U**$[\mathcal{R}, \mathcal{A}]$.

When we now combine **Acc** (6) and **Exp** (9) and apply it to science, we obtain:

> **AccExp**. *IF science always follows method $\mathcal{M}$ (for reaching some aim, $\mathcal{A}$ say), and never goes against it although nothing prevents science from doing so, THEN science accepts the concomitant methodological assumption* **U**$[\mathcal{M}, \mathcal{A}]$*, which asserts that the universe is such that following method $\mathcal{M}$ is of considerable help (for reaching $\mathcal{A}$).* (10)

The three premises we have gathered so far, **Ab** (2), **Acc** (6) and **Exp** (9), immediately throw a conclusion into our lap via consequence **AccExp** (10): thesis **U** (3) is the methodological assumption of a method that science *always* follows and *never breaks* according to **Ab** (2):

> **Lemma I.** *Science permanently accepts thesis* **U** (3). (11)

To arrive at premise P1 of the Argument from this Lemma I, we must argue that thesis **U** (3) is both substantial and metaphysical. We take these attributes in turn.

2.3 What is a Substantial Thesis?

When we agree to call a thesis 'substantial' in a particular context iff accepting or rejecting it has consequences that are generally recognised as important in that context, so that it 'makes a difference', then thesis **U** (3) is substantial if Maxwell is right that **U** is a necessary condition for the possibility of science. No thesis **U**, no science. Science being possible or impossible is the biggest difference one can imagine in the philosophy of science: no science, no philosophy of science! So let us focus on this particular 'important consequence' so as to make a thesis substantial:

If accepting a thesis is a necessary condition for the possibility of science, then it is a substantial thesis. (12)

Maxwell essentially has erected a 'transcendental deduction' to argue that if science were not to reject all aberrant theories in a single sweep but were to take them seriously, then scientific research and *a fortiori* scientific progress would come to an end, because scientists would drown in an ocean of aberrant theories of which each one would have to be *tested* before it could be rejected.[19] This testing, however, only works for aberrant theories that are empirically distinct from their regular sibling; science could not get rid of aberrant theories this way that are empirically equivalent to the regular theory. But this only makes Maxwell's case stronger, because aberrant theories with only aberrancies in the realm of the unobservable cannot be rejected on the basis of experimental tests; the only way to get rid of them seems to adopt thesis **U** (3) and act in accordance to it.

This transcendental argument is, however, not correct. Let us hold on to **Acc** (6) and **Exp** (9). Then *not* accepting thesis **U** (3) implies via Lemma I (11) that not-**Ab** (2): science does not reject some aberrant theories but accepts them. Does science, now, come to an end? Let us see.

Suppose all physicists were to agree to accept aberrant gravitation-theory NG1 rather than Newton's regular theory NG (see Section 2.1), in agreement with not-**Ab** (2). Then science would accept, and hence would not reject some aberrant theory. But science would definitely not come an end, let alone become impossible. In general, if scientists were to accept collectively a single aberrant version of every accepted regular theory, then science would *not* come to end. The only difference with science as we know it would be a few lines in every science book, asserting that a particular aberrancy will be set aside

[19] Cf. Maxwell (1974: 129), (1998: 192-193). Witness also the gist of this transcendental deduction in the displayed quotation in the the fifth paragraph of Section 2.1.

whence-forth. Scientific progress would remain very possible whilst *only* aberrant theories were accepted, in blatant contradiction to **U** (3) — and to **EmpU** (4).

So it seems we must conclude that Maxwell's transcendental argument is no good: wholly *rejecting* **U** (3) is fully compatible with the possibility of science and of science making progress. But let us be charitable and crawl a bit further along this line of reasoning.

Suppose now that every time a new theory (model, hypothesis) is proposed, scientists must convene to decide which aberrant version they choose. That would quickly become quite a drag. Since there are many scientists, a lot of time and effort would be wasted. Science would not come to an end all right, but it would progress more (but not much more) slowly. The need would arise for some general guideline to choose between aberrant theories, so that everyone chooses instantly the very same theory (model, hypothesis) and can continue with their research. The simplest guideline we can think of is this one: choose the regular version, or in other words, adopt thesis **U** (3) as a methodological assumption about the universe.

Maxwell could then argue that adopting **U** is, although admittedly not necessary for the possibility of science, it certainly is conducive for the growth of scientific knowledge, and he could submit that *this* is sufficient to call **U** *substantial*. Let us go along and accept the following sufficient condition for being 'substantial':

SignSubst. *If accepting or rejecting a thesis makes a significant difference in how fast science progresses, then the thesis is substantial.* (13)

We have judged Maxwell's transcendental argument for thesis **U** (3) being necessary for the possibility of science to be unconvincing, but we also have judged it convincing for a weaker thesis, namely the following one:

SignU. *Accepting or rejecting thesis **U*** (3) *makes a significant difference in how fast science progresses.* (14)

From **SignSubst** (13) and **SignU** (14) we then have:

SubstU. *Thesis **U*** (3) *is a substantial thesis.* (15)

Lemma I (11) and **SubstU** (15) together trivially imply

Lemma II. *Science permanently accepts a substantial thesis about the universe, namely thesis* **U** (3). (16)

The last thing we have to establish is whether thesis **U** (3) is metaphysics.

2.4 What is a Metaphysical Thesis?

Like his philosophical hero K.R. Popper, Maxwell considers 'scientific' and 'metaphysical' to be predicates of single statements (*e.g.* hypotheses) and classes of them (*e.g.* theories).

But, unlike Popper, who famously took *refutability* (if needed *given* a certain amount of background knowledge) as the criterion for being *scientific*, Maxwell rejects this criterion to demarcate science from non-science. Considering what is at stake, namely whether science presupposes metaphysical theses, one would have expected an elaborate discussion of the subject of demarcation somewhere in Maxwell's *opera*. Disapointingly no more than a single footnote in his *magnum opus* is devoted to the subject, from which we shall quote the core passage in full:

> A 'metaphysical' thesis, as understood here, is a general, factual thesis about the world which lacks the *precision* of a physical law or theory, and thus fails to make the precise empirical predictions of a law or theory.[20]

Let us immediately formulate what criterion Maxwell uses and then explain it with the futher sparse material on the subject-matter provided by Maxwell.

Meta. *A proposition is metaphysical iff it is a general proposition about the universe which is imprecise and irrefutable (if needed given a certain amount of background knowledge).* (17)

The notion of imprecision is vague, but that is precisely how Maxwell wants his conception of metaphysics to be: a proposition about the universe is *more scientific*, and consequently *less metaphysical*, if it becomes more precise (*ibid.*). Maxwell does not provide a general explication of the notion of precision, but sends the reader to bed with two illustrations: 'All matter is constituted of atoms' and Newton's law of universal gravitation with a completely unspecified constant of gravity are general imprecise proposition about the universe (*ibid.*); by themselves, they make no precise testable predictions.

Maxwell's idea seems to be that the less precise a general proposition about the universe is, the less capable it is to contradict particular states of affairs, with irrefutability presumably as the limit of being incapable to contradict any state of affairs whatsoever. This suggests that irrefutable statements are always imprecise. Anyhow, we have put both irrefutability and imprecision in **Meta** (17). We shall not further discuss **Meta**. Instead we focus on the question which is relevant for assessing the Argument, namely whether thesis **U** (3) is metaphysical. Certainly **U** is a general proposition about the universe. So in order to pronounce **U** metaphysical, **U** must be both imprecise and irrefutable. If, on the contrary, **U** turns out to be refutable or precise, **Meta** (17) permits us to conclude that **U** is not metaphysical.

One problem with arguing for the irrefutability of some statement (or class of statements) is familiar from discussions about Popper's demarcation-criterion. A statement S (or class ...) is irrefutable iff all implications of S are irrefutable, because as soon as a single refutable implication of S is found, this is sufficient (and necessary) to call S refutable.

[20] Maxwell (1998: 271).

We can never reach the conclusion that S is irrefutable because S has infinitely many implications. So if Maxwell wants to establish the metaphysical character of thesis **U** (3) in order to arrive at Maxwell's Thesis (P1), he wants to establish a conclusion that on the basis of **Meta** (17) is for humans impossible to establish. Therefore any claim of having established that thesis **U** is metaphysical will be a *non sequitur*.

But perhaps this is too quick. Perhaps one should not invoke what is (not) 'impossible for humans' in a philosophical argument. There are, in fact, cases where we can reach the verdict of irrefutability. Suppose we verified that four statements by themselves are irrefutable, say the Russell-Whitehead axioms of classical propositional logic; then arguably their deductive closure also is irrefutable. Hence it is humanly possible to reach the conclusion that an infinite class of statements is irrefutable. Is this also the case in **U** (3)?

Let us consider again a situation we considered in Section 2, where we have Newton's theory of universal Gravitation (NG) and the aberrant version with the golden spheres (NG1). When presented with both NG and NG1, thesis **U** (3) advices us to prefer NG. But NG1 is just as refutable as NG is, given a certain amount of background knowledge. Two golden spheres of 13 km radius which attract each other at some distance in accordance with Newton's inverse-square law forms a logically possible state of affairs with observable consequences in conflict with NG1. Hence NG1 is refutable. Suppose, for the sake of argument, that we find such a state of affairs repeatedly. Then NG1 stands refuted. If we find that the golden spheres, in fact, repulse each other, then NG stands refuted. This much is indisputable.

Now what would be the bearing on **U** (3)? If one wants to hold the permanent (implicit) acceptance of thesis **U** by science responsible for preferring regular theories over all aberrant versions — as the reasoning in favour of premises **Acc** (6) and **Exp** (9) goes (see Section 2.2) —, and one praises **U** (3) for this excellent methodological advice each time a regular theory is confirmed and a number of its aberrant versions is *ipso facto* refuted, then consistency in our behaviour of appraisal requires that one must also hold thesis **U** responsible when it persistently gives the wrong advice, as in our example, and then one should blame **U** (3) for that. Conversely, if **U** (3) were never to carry any blame for giving the wrong advice so as to be immune for refutation, then it could also play no rôle in understanding the practice of science. If we were to live in a universe where frequently aberrant theories turn out to save the phenomena and normal ones do not, then not a single soul would accept thesis **U** (3). Our conclusion is that thesis **U** (3) is vulnerable for experimental findings, if only via the theories **U** selects. But this is just to say that thesis **U** is *refutable* and then, by virtue of criterion **Meta** (17), is *not* metaphysical.

How about the (lack of) precision of thesis **U** (3)? Thesis **U** gives unambiguous advice to choose between two very precise theories, such as NG and NG1. Then it seems odd to

call **U** *imprecise*. Thesis **U** (3) will have both refutable and irrefutable consequences, and both precise and imprecise consequences. Should that render **U** metaphysical after all? Surely not. All accepted regular scientific theories also have irrefutable consequences, *e.g.* tautologies, and imprecise ones, *e.g.* NG entails that planets attracht each other inversely proportional to r^n, where $0 < n < 10^{10}$. Should we, then, go on and render also all accepted scientific theories metaphysical?

To summarise, thesis **U** (3) has an infinitude of precise and refutable implications; it has ton-loads of precise empirical content. Intuitively such a thesis can hardly be called metaphysical. Maxwell's criterion **Meta** (17) vindicates this intuitive judgment: according to it, **U** is definitely *not* a metaphysical thesis. So the final step, from Lemma II (16) to Maxwell's Thesis, which is premise P1 of the Argument, is a *non sequitur*. Furthermore, it is difficult to see how **U** (3) could be called 'metaphysical' by weakening criterion **Meta** (17) and still having a non-trivial criterion left that would render thesis **U** metaphysical and scientific theories not.[21]

2.5 Assessment of the First Aberrance-Argument

We summarise our assessment of the first aberrance-argument. The logical structure of it looks like this:

$$\begin{aligned}
&\textbf{Acc}\ (6)\ \wedge\ \textbf{Exp}\ (9) && \longrightarrow\ \ \textbf{AccExp}\ (10)\ ,\\
&\textbf{AccExp}\ (10)\ \wedge\ \textbf{Ab}\ (2) && \longrightarrow\ \ \textbf{Lemma I}\ (11)\ ,\\
&\textbf{SignSubst}\ (13)\ \wedge\ \textbf{SignU}\ (14) && \longrightarrow\ \ \textbf{SubstU}\ (15)\ ,\\
&\textbf{SubstU}\ (15)\ \wedge\ \textbf{Lemma I}\ (11) && \longrightarrow\ \ \textbf{Lemma II}\ (16)\ .
\end{aligned} \tag{18}$$

These four arguments lead to the following conclusion:

$$\begin{aligned}
\big(\textbf{Acc}\ (6)\ \wedge\ \textbf{Exp}\ (9)\ \wedge\ \textbf{Ab}\ (2)\ \wedge\ \textbf{SignSubst}\ (13)\ \wedge\ \ \textbf{SignU}\ (14)\big)&\\
\longrightarrow\ \textbf{Lemma II}\ (16)\ .&
\end{aligned} \tag{19}$$

The final step fails:

$$\big(\textbf{Meta}\ (17)\ \wedge\ \textbf{Lemma II}\ (16)\big) \not\longrightarrow \text{(P1) Maxwell's Thesis}\ . \tag{20}$$

Hence the entire first aberrance-argument fails:

$$\begin{aligned}
\big(\textbf{Acc}\ (6)\ \wedge\ \textbf{Exp}\ (9)\ \wedge\ \textbf{Ab}\ (2)\ \wedge\ \textbf{SignSubst}\ (13)\ \ \wedge\ \textbf{SignU}\ (14)\big)&\\
\not\longrightarrow \text{(P1) Maxwell's Thesis}\ .&
\end{aligned} \tag{21}$$

[21] Logically weakening **Meta** by replacing 'iff' in (17) with 'if' or 'only if' will not do: if (17) is only a sufficient condition, we have no ground to call thesis **U** metaphysical and the *non sequitur* remains; if (17) is only a necessary condition, then we have no grounds to call **U** (3) *not* metaphysical by virtue of it.

The acknowledgment that step (20) of the first aberrance-argument makes it a *non sequitur* is independent of whatever view one has on science. The same holds for the acceptance of the premises **Ab** (2), **SignSubst** (13) and **SignU** (14), or so we submit. But it does not hold for the premises **Acc** (6) and **Exp** (9), as we shall see presently. In the context of assessing the Argument as directed agains Constructive Empiricism (CE), the relevant question to ask here is whether **Acc** (6) is objectionable in the eyes of CE. In these eyes, **Acc** (6) does not seem plausible, because **Acc**, going from observable behaviour to unobservable mental states, smacks too much of an Inference-to-the-Best-Explanation (IBE), which is a mode of inference that Van Fraassen is very critical about, in particular when it concerns an *explanandum* about observables only and an *explanans* which is about unobservables too.[22] A proponent of IBE would submit that if someone accepts methodological assumption **U**, then this 'explains' why he expects to be successful when following the associated methodological rule 'reject aberrant theories' (2), and this, in turn, 'explains' why he actually always follows this rule. This is essentially the kind of explanation we provide when we say that Nick is eating (observable behaviour) *because* he is hungry (his mental state). When we infer from an eating Nick that he is hungry, we make an IBE. Apart from the question whether this really explains anything (this stuff makes people sleepy because it has property X and X has a tendency to make people sleepy), anyone who is critical of IBE in general can now start digging his heels in to resist premise **Acc** (6).

To show that premise **Acc** (6) definitely is an IBE in disguise, it is sufficient to provide at least one other explanation; then one can go on to ask why accepting thesis **U** is the *best* explanation, and to ask how Maxwell knows there are not *more* explanations, and to ask how we know the *best* one is among the ones we happen to have formulated (it may be 'a bad lot'), *etc.*

To begin with: what *other* explanation is there for **Ab** (2) but the acceptance of **U** (3)? Well, just as there can be other explanations of why Nick is eating besides him being hungry (such as: doctor's orders; it is part of a bet; he is only tasting the food but is not hungry at all; he proves to his wife that the food is not tainted; *etc.*), there is an alternative explanation for following **Ab** (2). This explanation is thoroughly *aesthetical* in nature: science rejects aberrant theories (**Ab**) because they are *ugly*; science operates by means of the following selection-criterion:

> **Beauty.** *A theory is accepted iff so far it has saved all the established phenomena which it is supposed to save and it is beautiful.* (22)

Criterion Beauty (22) does not overtly involve metaphysics. A propounder of Beauty (22) may look upon Rule **Ab** (2) as a celebration of a remarkable agreement in 'subjective

[22] Fraassen (1989: 131-150).

taste', slight individual differences notwithstanding — a 'scientific taste' which is constitutive for the scientific culture.

We can think of even a third explanation for following **Ab** (2), which is thoroughly *instrumentalist* in nature: science rejects aberrant theories (**Ab**) because they are unnecessarily complicated to apply, they have redundant epicycles. Science operates by means of the following selection-criterion:

> **Instrument.** *A theory is accepted iff so far it has saved all the established phenomena which it is supposed to save and is the most easy of all available theories to apply.* (23)

Just like criterion Beauty (22), Instrument (23) does not overtly involve metaphysics. Unlike a propounder of Beauty, who speaks about aesthetics and the necessity of beauty to make our gray and routine-ridden lives a sense of profundity, a propounder of Instrument (23) speaks about applications and efficiency, praises ingeneering and inventing useful and useless gadgets to make our gray and routine-ridden lives joyful.

Criterion Beauty (22) is not entirely a philosopher's fiction that has nothing do to with science as we know it, because certain brilliant physicists considered beautiful theories to be ends in themselves, such as Dirac, and Weinberg [1992: 165]: "And in any case, we would not accept any theory as final unless it were beautiful." Criterion Instrument (23) seems a little less likely to be such a fiction. Nonetheless we are prepared to adopt the conjecture that scientists reject aberrant theories not because these theories go against their personal, subjective, contingent taste ('ugly') or are unnecessarily clumsy to be efficiently applied, but because scientists are more likely to accept in their hearts that Mother Nature simply does not work in the way aberrant theories say She works — which is precisely what thesis **U** (3) captures. How to justify this conjecture when we cannot *ask* scientists because they suffer from having a false consciousness called 'Standard Empiricism', as Maxwell would have it? Anyhow, sceptics about IBE such as Van Fraassen now certainly have some ground to dig in their heels. Whether or not criteria Beauty (22) and Instrument (23) have anything to do with actual science is irrelevant. What is relevant is that there is more than one explanation conceivable and this is enough to demonstrate that **Acc** (6) *is* an IBE in disguise.

Perhaps this is the appropriate moment to wave a red flag against Maxwell's psychiatric diagnosis of scientists collectively suffering from a false consciousness (Section 2.2). We believe it is possible to explain to any individual scientist carefully the issues we have been discussing so far, drawing the distinctions we have been drawing and will be drawing (*e.g.* between acceptance and belief); and then go on to ask hin whether he accepts thesis **U** (3), or believes **U** to be true, or counts **U** to our scientific knowledge about the universe, then to repeat the same questions about **EmpU** (4), and so to obtain honest and fully conscious answers about the issue at hand. We expect that every scientist will declare at least that he *accepts* thesis **U** (3) as a 'working hypothesis' until the facts tell

otherwise, *because* not making it would slow down the growth of scientific knowledge considerably, and *because* no aberrant fact has been established so far. *As we shall see*, such acceptance of thesis **U**, as Lemma I (11) says, and the acknowledgment that **U** is substantial, as Lemma II (16) says, do not have the sensational philosophical consequences Maxwell believes they have.

Hence our conclusion about the first aberrance-argument (18) remains that Lemma II (16) is plausible, but the step to Maxwell's Thesis (P1) is a *non sequitur* because thesis **U** (3) is *not* a *metaphysical* thesis according to Maxwell's own criterion **Meta** (17) — or according to any non-trivial weakening of **Meta** for that matter. Critics of IBE, to repeat, will not even find Lemma II plausible because it relies on the IBE-like premise **Acc** (6). So it seems that CE is already in the clear.

2.6 Deductive Logic

There is a second aberrance-argument present in Maxwell's writings (although it surfaced most explicitly in correspondence) which *prima facie* circumvents the issue of IBE and purports to be a strictly deductive argument, in particular without having to appeal to premises **Acc** (6) or **Exp** (9). This second aberrance-argument has premise **Ab** (2) in common with the first one. Its second premise is the eminently reasonable premise saying that if someone accepts a proposition and this proposition deductively entails another proposition, then one must accept that other proposition too:

Closed. *Acceptance is closed under deduction.* (24)

Premise **Closed** is part of *accepting deductive logic*, which we take to mean (no more than) the following: (a) acceptance of all theorems of deductive logic; (b) rejection of all their negations, notably contradictions; (c) acceptance of a piece of reasoning as valid if in it only deduction-rules from deductive logic are correctly applied; and (d) acceptance is closed under deduction, which is **Closed**. For the sake of future reference, we define:

Logic. *Deductive logic is accepted.* (25)

Logic trivially implies **Closed** but not conversely. For 'deductive logic' various kinds of logic can be substituted; in this paper we substitute 1st-order classical predicate logic, which includes classical propositional logic.

Let us put to rest one worry that may arise here. The worry is that since physics accepts both Newtonian Gravity (NG) and Einstein's General Theory of Relativity (GTR), physics by implication accepts contradictions because these theories contradict each other, and therefore (!) physics *rejects deductive logic*. This is, however, too quick. Physics certainly does not accept these two theories unconditionally, but at least in relation to a class of

phenomena, characterised in terms of the scale of certain physical magnitudes. When we deal with gravitation-phenomena on the grand cosmic scale, GTR is accepted, not NG; when we deal with gravitation-phenomena and only want a comparably small number of correct digits in the results of calculations, NG is accepted; and when we deal with gravitation-phenomena 'at the Planck-scale', neither NG nor GTR is accepted. When we talk about the acceptance of the 'ontology' of two conflicting theories, the one (if any) of the empirically best will be accepted. In these manner the acceptance of contradictions is avoided.

We now proceed to the second aberrance-argument.

2.7 Assessment of the Second Aberrance-Argument

Suppose physics accepts theory T. Then by virtue of **Ab** (2), theory T is regular. Let T^* be an aberrant version of T. Then T and T^* contradict each other precisely there where T^* differs from T; this is logically the same as: if T, then not-T^*. Then physics also accepts not-T^*, as premise **Closed** (24) prescribes.

But what *is* 'not-T^*'? Recall that T^* is, for Maxwell, an infinite class of statements. The statements which T^* has in common with T must not be denied, otherwise physics is accepting contradictions; all the others can be denied and these denials belong to 'not-T^*', as long as they are consistent with T. The negations of statements of T^* that do not belong to the language of T, abbreviated by $\mathcal{L}(T)$, can be lumped into 'not-T^*' without any danger of contradictions arising. Let us call the ensuing class of statements the *Negation of T^* with respect to T* (with a capital N), denoted by

$$N(T^*, \mathrm{T}) \;\equiv\; \left\{\; \neg S \in \mathcal{L}(T^*) \;\middle|\; S \in \mathcal{L}(T) \;\longrightarrow \big(\mathrm{Con}(T,\, \neg S) \wedge\; S \in\; T^*\big) \;\right\}, \qquad (26)$$

where $\mathrm{Con}(T,\ \neg S)$, denoting the consistency of class $\{T,\ \neg S\}$, is defined as no contradiction being derivable from this class of two statements. Since T^* is arbitrary, we arrive at the following result:

Lemma III. *Science accepts the negation of every aberrant version of an accepted regular theory T in so far as it is compatible with T, which is to say that science accepts the Negation $N(T^*, T)$ (26) of every aberrant version T^* of T.* (27)

Lemma III (27) does not say that science *accepts* thesis **U** (3), like Lemma I (11) does. Or does it? Let us see. Lemma III asserts that science accepts lots of denials and thus does not accept, and usually rejects, the corresponding affirmations. These denials make assertions about (certain aspects of) the universe. Hence science accepts an infinitude of assertions about the universe, all of the type asserting that the universe is *not* like such and such (because they are denials). But is accepting all denials of aberrant statements not tantamount to accepting thesis **U** that the universe is comprehensible (3)? Clearly, in

the light of Lemma III, it is not consistent to accept not-**U**. That is to say, Lemma III (27) and **Logic** (25) imply

Lemma IV. *Science does not accept that the universe is incomprehensible, that is to say, science does not accept not-***U** (3). (28)

When we adopt the extremely plausible principle that false theories (and known to be so) are rejected, and recall that accepting classical logic (25) includes accepting that a non-false statement is true, then we have the following equivalent formulation of Lemma IV:

Lemma IV'. *Science does not accept that the universe is such that it makes even a single aberrant theory true.* (29)

Lemma IV entails that science does accept thesis **U** (3) if, and only if, the following principle is adopted:

Neg. *Not accepting a proposition implies accepting its negation.* (30)

For if science refuses to accept not-**U**, principle **Neg** (30) says that science does accept the negation of not-**U**, which is **U** (according to classical logic a double denial implies an affirmation). So Lemma IV (28) and **Neg** together imply Lemma I (11), but Lemma IV (28) alone does not imply Lemma I.

The logical structure of the second aberrance-argument looks like this:

$$\begin{aligned}
&\textbf{Logic}\ (25) && \longrightarrow && \textbf{Closed}\ (24)\ ,\\
&\textbf{Ab}\ (2)\ \wedge\ \textbf{Closed}\ (24) && \longrightarrow && \textbf{Lemma III}\ (27)\ ,\\
&\textbf{Lemma III}\ (27)\ \wedge\ \textbf{Logic}\ (25) && \longrightarrow && \textbf{Lemma IV}\ (28)\ ,\\
&\textbf{Lemma IV}\ (28)\ \wedge\ \textbf{Logic}\ (25)\ \wedge\ \textbf{Neg}\ (30) && \longrightarrow && \textbf{Lemma I}\ (11)\ .
\end{aligned} \tag{31}$$

This leads to the following valid argument for Lemma I:

$$\textbf{Ab}\ (2)\ \wedge\ \textbf{Logic}\ (25)\ \wedge\ \textbf{Neg}\ (30) \quad \longrightarrow \quad \textbf{Lemma I}\ (11)\ . \tag{32}$$

In contrast to the first aberrance-argument (18), we have a valid deductive argument for Lemma I (11) without premises that smack of IBE, which was anathema to CE. But now we have to ask whether principle **Neg** (30) is a reasonable premise. Before we answer this, we point out that **Neg** is not included in accepting **Logic** (25).[23] To return to our question, it is one thing to say that every proposition is either true or false, and that one

[23]Only in the case one has accepted a so-called 'deductively complete theory' (meaning: if statement *S* is not provable in the theory, then not-*S* is a theorem), this holds for sentences in the language of that theory. Such cases are extremely rare; most theories, in so far as investigated by formal means, turn out to be deductively *incomplete*.

either has to accept or not to accept it, but it is quite another thing to say that one either has to accept *every* proposition or to accept its denial, which is what principle **Neg** (30) entails. It seems perfectly reasonable not to accept a certain proposition and also not to accept its denial. To put it another way, if principle **Neg** is reasonable, then doubt or a neutral attitude is not reasonable anymore, because to doubt a proposition, or remaining neutral with regard to it, involves precisely neither accepting nor rejecting it. But surely there is such a thing as reasonable doubt and such a thing as remaining neutral!

So it seems that on the basis of **Ab** (2) and **Closed** (24), we cannot reach deductively beyond Lemma IV (28), in particular we cannot reach Lemma I (11). Then we cannot reach Maxwell's Thesis (P1) either.

Finally, it serves to mention that it is quite straightforward to arrive at Lemma I (11) from Lemma IV (28) by means of an IBE, where Lemma I, then, is the admittedly trivial *explanans* and Lemma IV the *explanandum*: science does not accept that the universe is incomprehensible because science permanetly accepts that the universe is comprehensible. If arrived at Lemma I, and then at Lemma II (16) by virtue of conclusion **SubstU** (15), the same problem we faced in the case of the first aberrance-argument stares one in the face: **U** is *not* a *metaphysical* thesis by virtue of **Meta** (17) because it boasts with precise empirical content.

We end by drawing attention to the fact that Standard Empiricism (SE) still stands firmly on its feet (and so does CE), because without Maxwell's Thesis (P1), conclusion C1 of the Argument is a *non sequitur*.

3 Constructive Empiricism Confuted?

In the previous Section we have concentrated on the arguments Maxwell has propounded in favour of premise P1 of the Argument and we found them unconvincing. But the Argument also relied on a second contentious premise (P2), asserting that Constructive Empiricism (CE) is a version of Standard Empiricism (SE). In the present Section we focus on premise P2. Our conclusion will be that P2 is false, but can be made true when SE is substantially revised.

3.1 Some Principles of Constructive Empiricism

B.C. van Fraassen's Constructive Empiricism (CE) is generally held to be the only well-developed non-instrumentalist alternative to the varieties of realism; it proudly stands in the tradition of the Vienna and Berlin Circles.[24] We first rehearse a few tenets of CE which are necessary for our present purposes (we shall label them for the sake of future

[24]See Fraassen (1980), (1989).

reference); then we judge Maxwell's assertions about CE in the Argument, in particular premise P2.

Fundamental for CE are two distinctions: a distinction between *pragmatic acceptance* and *epistemic belief*, or *belief in the truth* (two different mental attitudes, each having different implications), and an admittedly vague and anthropomorphic yet perfectly meaningful distinction between *observable* and *unobservable* objects. For Van Fraassen, science is neither a wholly epistemic endeavour (as it was for logical-positivists and is for most if not all realists) nor a wholly pragmatic endeavour (as it is for instrumentalists), but it is a mixture of both.

Let T be a scientific theory. T is called *empirically adequate* iff T saves every relevant phenomenon, observed or not, in past, present and future of our universe; and T is *logically adequate* iff T does not produce contradictions. Consider the following conditional:

If someone accepts theory T, then this involves the belief that T is both logically and empirically adequate. (33)

(Since inconsistent theories cannot be empirically adequate, the first necessary condition of acceptance can be deleted.) A constructive empiricist believes *no more* about an *accepted* theory than what is mentioned in the necessary condition in (33), and remains neutral with regard to any further additions going beyond the actual observable, whereas a realist believes *more*, like that the accepted theory is also ontologically adequate, as in **Truth** (5), so that it also tells us the truth about what happens in the unobservable part of the world. Then being a constructive empiricist and being a realist are logically incompatible categories; what they share, however, is their obedience of (33).[25]

Van Fraassen gladly permits scientific virtues such as simplicity, explanatory power, unifying capacity, and *a fortiori* being regular (non-aberrant) to play a rôle in the decision to accept or to reject a scientific theory (as they unquestionably do), but holds that these scientific virtues are not *epistemic* virtues. For CE, the only epistemic virtues are logical and empirical adequacy. Yet in spite of their being epistemically void, *they are scientific virtues nonetheless*, because having them is expedient for reaching the aims of science, in particular the epistemic aim of science:

(CEP1) *Epistemic Aim of Science.* The epistemic aim of science is empirical truth, *i.e.* the construction of (logically and) empirically adequate theories. (34)

Let it finally be noted that Van Fraassen is a fastidious epistemologist; he rarely speaks of 'knowledge' or 'scientific knowledge'. Nevertheless one can identify in CE at least three genuinely Epistemic Principles; one of which is CEP1 (34), stating what the epistemic aim of science is, the other two being the ones below. This should not come as a

[25] Cf. Fraassen (1980: 8, 12), (1989: 193).

surprise, because the main product of the fabric of science is knowledge; it would be extremely awkward if a view of science were devoid of epistemological elements. Below a *accepted scientific proposition* is a proposition that is licensed by some accepted scientific theory.

(CEP2) *Epistemic Policy.* A proposition counts as *scientific knowledge*, and is *believed to be true*, iff it is an accepted scientific proposition and is about actual observables only; if the accepted scientific proposition is also or only about unobservables, it does not belong our scientific knowledge, it is neither believed as true nor as false (one remains neutral *qua* belief), but is merely accepted. (35)

(CEP3) *Scientific Virtues.* Logical and empirical adequacy are the only two epistemic virtues; all other virtues are pragmatic; *all* scientific virtues, epistemic as well as pragmatic ones, are permitted to play a part in the decision to accept or to reject a scientific theory. (36)

3.2 Constructive Empiricism contradicts Standard Empiricism

For CE, *not only* the evidence decides whether to accept or to reject a theory (36), contrary to part SE2 of Maxwell's characterisation of SE (1) of the Argument. So CE contradicts SE2 and therefore *is not* a version of SE. Premise P2 of the Argument is false.

Furthermore, CE contradicts condition SE1 of SE (1), because according to principles CEP2 (35) and CEP3 (36), CE *can accept* thesis **U** saying that the universe is comprehensible (3). In so far as **U** has implications about actual observables, principle CEP2 says one *must* and therefore surely can believe these implications are *true*; that is to say, CE *commits us to believing in the truth of* **EmpU** (4) as soon as **U** is *accepted* — as Lemma I (11) says that science does. This contradiction between CE and SE1 leads us, again, to conclude that premise P2 of the Argument is false.

Surprisingly, we can move beyond mere logical compatibility between accepting thesis **U** (Lemma I) and CE. Van Fraassen has enriched CE with a 'libertarian' concept of rationality which is supposed to be understood as 'bridled irrationality': believing a proposition is *rational* iff one is not compelled to disbelieve it; hence *irrational* iff one is compelled to disbelieve it.[26] One remarkable consequence is that believing in the existence of electrons, something which goes against epistemic principle CEP2 (35), is deemed rational, as is disbelieving it and as is remaining neutral about it. From these consequences it should not be concluded that CE has become inconsistent, but that CE embraces a 'libertarian' notion of rationality that can make contradicting conceptions of science rational. We now submit that *qua scientists* scientists are *compelled* to act in accordance to methodological assumption **U** (3) in order not to slow down needlessly the process of progressing towards the aim of science (34). Then it is *irrational* for science to *reject* thesis **U** and

[26] Fraassen (1989: 171-172).

not follow the associated methodological rule 'reject aberrant theories'. Therefore it certainly is *rational* to accept **U** and act accordingly. With rationality backing us up, we now have moved beyond mere logical compatibility between accepting thesis **U** (3) and CE, as promised — and this conclusion is even more painfully dissonant to premise P2 of the Argument.

3.3 Two Varieties of Standard Empiricism

Lately Maxwell (1998: 37) has drawn a distinction between two varieties of SE (our emphasis):

> We can, in fact, distinguish two versions of SE *which differ on just this question* of whether empirical considerations ought *alone* to determine choice of theory in science, or whether simplicity considerations [*e.g.* whether being regular or aberrant — FAM] are important and legitimate *in addition* to empirical considerations. Let us call the first view *bare* SE (bSE) and the second *dressed* SE (dSE).

So far we have been considering the bare version (bSE); it was twice incompatible with CE and therefore rendered premise P2 twice false (Section 3.2). Let us see whether a version of the Argument with dressed SE (dSE), rather than bare SE (bSE), can touch CE.

Clearly the weakening of bSE to dSE that Maxwell considers only affects SE2 (Maxwell: "differ on just this question ..."), not SE1 (1). Thus we now have:

> **Dressed Standard Empiricism (dSE).** (SE1) *Science does not accept any permanent, substantial, metaphysical assumptions about the universe (independent of the evidence and certainly never in violation of the evidence)* (1); *and* (dSE2) *the decision to accept or to reject a scientific theory is generally based on empirical grounds (the available evidence) and non-empirical grounds (regularity, simplicity, explanatory force, unifying power and perhaps more).* (37)

CE endorses dSE2 (37) wholeheartedly because principle CEP3 (36) of CE entails dSE2. But CE remains incompatible with dSE because, as we demonstrated in the previous Section, it is incompatible with SE1 (1), which is part of dSE (37). Hence we conclude that the move from bare to dressed SE in order to make trouble for CE helps but it does not help enough. CE is a more liberal species of empiricism than both bSE (SE (1)) and dSE (37), and therefore immune for the Argument. Premise P2 of the Argument remains false.

3.4 A Third Variety of Standard Empiricism

In contradiction to the conclusion we have just drawn, namely that CE is neither a variety of bare SE nor of dressed SE, Maxwell claims that CE *is* a variety of bSE:

> However, Van Fraassen is emphatic that *only* empirical considerations can legitimately decide what is accepted *as scientific knowledge*, simplicity having here no role to play whatsoever: it is this that makes him a proponent of bare SE.[27]

When Maxwell claims that in CE "only empirical considerations can legitimately decide what is accepted as scientific knowledge", he misunderstands CE, because prior to finding out whether a proposition is about actual observables only (the stage where "only empirical considerations ..."), it first needs to be ascertained whether this proposition is part of an accepted scientific theory and at that stage non-empirical considerations can legitimately help to reach a decision of acceptance or rejection CEP3 (36); in the entire two-stage process of deciding whether a proposition is accepted as knowledge *not only* empirical considerations are legitimate. Maxwell has unjustifiably ignored the first stage.

What Van Fraassen (1980: 4) means when he says things like "... pragmatic virtues do not give us any reason over and above the evidence of the empirical data for thinking that a theory is true," is that these virtues play no rôle at the second stage; their rôle is restricted to the first stage. If we have two empirically equivalent theories and one evidently has more explanatory power than the other one, then we accept that one because we think this move is conducive for reaching the aim of science (34); but we do not believe that the explanatory theory is closer to the truth, more likely to be true, or whatever genuinely epistemic concept (by the lights of CE) you want to use here. The dunghill of history is filled with false explanatory theories.

The only way to save what Maxwell is trying to say here is to take him as shifting the entire Argument from the pragmatic stage of acceptance & rejection *simpliciter* to the epistemic stage of acceptance & rejection *as scientific knowledge*. This interpretation is in harmony with Maxwell more recent formulations of SE, in particular of SE1:[28]

> no substantial thesis about the world being permanently upheld *as a part of scientific knowledge* independently of empirical considerations.

We point out that here the "substantial thesis" is no longer called 'metaphysical', as in his (1974) *passim*. But since in Maxwell's own conception of science the whole of knowledge is subdivided in 10 levels and he calls all levels beyond level 1 (the evidence) and level 2 (theories) "*metaphysical*, cosmological assumptions concerning the comprehensibility and knowability of the universe" (1998: 6), we can be certain that the "substantial thesis" in the quotation displayed above deserves to be called *metaphysical*.[29]

[27] Maxwell (1998: 38).

[28] In Maxwell (1998: 2); cf. Maxwell (2002: 1-2).

[29] Cf. Maxwell (1993: 66-69), (2002), and Section 3.6 for this topic.

Let us thus define 'revised dressed Standard Empiricism' as follows:

Revised dressed Standard Empiricism (dSE*). (SE1*) *Science does not accept any permanent, substantial, metaphysical assumptions about the universe (independent of the evidence and certainly never in violation of the evidence)* as a part of scientific knowledge*; and* (dSE2) *the decision to accept or to reject a scientific theory is generally based on empirical grounds (the available evidence) and non-empirical grounds (regularity, simplicity, explanatory force, unifying power and perhaps more)* (37). (38)

In comparison to dressed Standard Empiricism (dSE) (37), this revised version of it (dSE*) has a different, stronger first conjunct: SE1* rather than SE1 (37); in comparison to Standard Empiricism (SE), this revised version of dressed Standard Empiricism (dSE*) has two different conjuncts: the stronger SE1* rather than SE1 (1) and the weaker dSE2 (37) rather than SE2 (1).

Another way of putting Maxwell's move from dressed SE (37) to dSE* (38) is to say that he surreptitiously changes the meaning of 'acceptance': from acceptance in Van Fraassen's sense of pragmatic acceptance *simpliciter* to acceptance in Van Fraassen's sense of epistemic acceptance, as being 'part of scientific knowledge'. If we were to put it like this, then another line of attack on CE would ensue, because also in this sense Maxwell would not commit the fallacy of equivocation with respect to 'acceptance', provided we change the meaning of 'acceptance' everywhere in the Argument accordingly and take 'scientific knowledge' in Van Fraassen's sense — otherwise another fallacy of equivocation would be committed. And if SE1 (1) was always intended to be understood as SE1* (38), then what follows next is directed at the Argument *thus understood*.

The global logical structure of the Argument (Section 1) remains unaffected by these surreptitious changes, but we now have to review our assessment of premises P1 and P2. Premise P2 now reads that CE is a version of Revised dressed Standard Empiricism (dSE*) because it meets both of *its* characterising conjuncts, SE1* (38) and dSE2 (37). We have already seen that CE meets dSE2. Does it meet SE1* too? When metaphysical theses are such that they do *not* stick their neck out to face the tribunal of sense experience, in agreement with **Meta** (17), CE will never consider such theses as candidates for entering the body of scientific knowledge, in agreement with requirement SE1* (38). Hence CE *is* a version of revised dressed Standard Empiricism (dSE*), which makes premise P2 of the revised Argument true. So far so good.

But now to make premise P1 true, or at least plausible, it is insufficient for an aberrance-argument to establish that science *accepts* thesis **U** that the universe is comprehensible (3), as Lemma I (11) asserts. One must establish a logically stronger version of Lemma I (11), namely that science accepts **U** *as part of scientific knowledge in Van Fraassen's sense*; from this we then have to go to a stronger, epistemic version of Maxwell's Thesis P1. Let us consider the two aberrance-arguments in turn, which are supposed to ground premise

P1.

Revised First Aberrance-Argument. This argument clearly needs a *stronger* version of **AccExp** (10); namely the following one:

> **AccExp*.** *IF science always follows method $\mathcal{M}$ (for reaching some aim, $\mathcal{A}$ say), and never goes against it although nothing prevents science from doing so, THEN the concomitant methodological assumption $\boldsymbol{U}[\mathcal{M}, \mathcal{A}]$ that the universe is such that following method $\mathcal{M}$ is of considerable help (for reaching $\mathcal{A}$) belongs to the scientific knowledge of the universe.* (39)

The ensuing argument arriving at an epistemic version of Lemma I (11) begins to look suspiciously much like a *petitio principii*: if one is prepared to accept premise **AccExp*** (39) without further argument, then one might as well accept an epistemic verision of Lemma I right away.

But in fact, assumption **AccExp*** (39) is not plausible. Since for CE what belongs to our scientific knowledge is the object of true belief and can only involve actual observables, assumption **AccExp*** is, then, telling us we can read off (what scientists' take to be) scientific knowledge from their observable behaviour. This is generally implausible: one can act against one's own beliefs: out of desperation, or out of habit, to please someone you love, and so forth. We are dealing here, in assumption **AccExp*** (39), with a fully fledged IBE. This is sufficient to conclude that CE — a sworn enemy of IBE — is certainly not compelled to accept premise **AccExp*** of the revised first aberrance-argument.

Furthermore, we want to point out the following. For CE, the pragmatic acceptance of thesis **U** (3) already involves an epistemic commitment according to CEP2 (35) of CE, namely to believe that thesis **U** (3) is empirically true, *i.e.* that thesis **EmpU** (4) is true. This is to say that **EmpU** is part of our scientific knowledge of the universe in Van Fraassen's sense! If Maxwell were to respond that counting **EmpU** to our scientific knowledge is not enough, and that CE *must* count the logically stronger thesis **U** to our scientific knowledge, then this would be tantamount to demanding CE to betray one of its constitutive epistemic principles (CEP2), namely to withhold belief in anything that goes beyond the actual observable (35). But the debate whether this principle (CEP2) is good or bad is quite another debate; more importantly, Maxwell did neither direct the Argument against this principle nor did this principle play a part in the Argument. The conclusion is that Lemma I (11) implies, for CE, that **EmpU** (4) is part of scientific knowledge. Since this is not in conflict with CE, this provides no ground for the rejection of CE.

Revised Second Aberrance-Argument. See above.

Our assessment is that the revised Argument, with revised dressed Standard Empiricism (38) replacing Standard Empiricism (1) and concomitantly revised premises, is an improvement on the original Argument because it turns the false premise P2 into a true one. But the revised Argument is a deterioration when it comes to premise P1; the original

aberrance-arguments could plausibly reach Lemma I, stating that science accepts thesis **U** (3), but a revised Lemma I, stating that science counts **U** to our *scientific knowledge*, can no longer be reached plausibly because the IBE-type premise **AccExp*** (39) is not quite at home in CE.

3.5 Varieties of Acceptance

In the present context, *prima facie* five notions of 'acceptance' are to be distinguished:[30]

(Acc) Van Fraassen's *pragmatic acceptance* of a proposition, with or without some particular aim in mind.

(T) Van Fraassen's *epistemic acceptance* of a proposition, acceptance of it as part of our scientific knowledge (in Van Fraassen's sense of about actual observables only), of belief in its truth.

(Post) Maxwell's acceptance as 'part of our conjectural *a posteriori* scientific knowledge'. (40)

(Post) Maxwell's acceptance as 'part of our permanent *a priori* scientific knowledge'.

(Sc) Acceptance as understood by science (whathever that is).

A systematic comparison of all five notions is not needed for our present purposes of criticising Maxwell. But to keep seeing the wood between the trees, and, more importantly, to prevent any worries about our critical analyses from arising in this light, the following remarks should be enough.

Maxwell intends his (Post) to be the same as (Sc). This collapses one distinction. Next, in order not to let Maxwell commit the fallacy of equivocation with respect to 'acceptance' in his criticism of CE, each of (Acc) and (T) can be chosen in the Argument, provided we choose consistently. This is precisely what we have done in the previous Sections: on both accounts the Argument against CE failed. So we now only need to consider the two other notions of acceptance which are left: (Prior) and (Post).

If Maxwell were to use 'acceptance' in the Argument in any of *his* two senses of (Prior) or (Post), and not in any of Van Fraassen's two senses of (Acc) or (T), he might still have evaded the charge of committing the fallacy of equivocation, because certain logical relations seem to obtain between his and Van Fraassen's notions of acceptance. Maxwell could, perhaps, erect some version of the Argument on the basis of these logical relations. We believe, however, that the prospects for this project are dark, as we shall finally argue.

Since (Post) certainly implies (Acc), the premises of a version of the Argument using (Post) imply the premises of the Argument with (Acc). We therefore can reject the ver-

[30] Fraassen (1980: 11-13, 46, 88), (1989: 191-193), Maxwell (1998: 20).

sion of the Argument with (Post) as soon as we reject the version with (Acc). But this is precisely what we have done already. And *mutatis mutandis* for (Prior), because (Prior) certainly implies (T).

3.6 Farewell to Metaphysics?

In the previous Sections we have seen that Maxwell's Thesis (P1) does not follow from Lemma II (16) by means of **Meta** (17) and that the prospects of weakening **Meta** seemed dark because thesis **U** (3) is filled with precise empirical content. Now what if Maxwell simply deletes 'metaphysical' altogether everywhere in the Argument and is satisfied with Lemma II?

Well, first of all, this move will take a sting out of the Argument. The slogan of the Argument — *Science Presupposes Metaphysics!* —, which attracts the attention of the philosopher of science, then must go. Is there anything philosophically exciting left after this move? Let us see.

Deleting 'metaphysical' everywhere yields yet another weakened version of SE, a version to be sure which is no longer hostile to making *metaphysical* assumptions. The view which then seems to be under fire of the Argument we call 'Heraclitism' (after the pre-Socratic philosopher who said *Panta rhei*):

Heraclitism. *Science does not accept any permanent, substantial assumptions about the universe.* (41)

To relate Heraclitism (41) to SE (1): it is a further weakening of its first conjunct (SE1), and it has no second conjunct.

The drawback of this move is that Heraclitism (41) sits less comfortably in the philosophical tradition called 'empiricism'. This tradition is characterised by its *anti-metaphysical attitude*, as expressed in SE1 (1) and in SE1* (38). Thus we can hardly call Heraclitism (41) a 'fourth variety of Standard Empiricism'. For reasons that by now need not be rehearsed, a revised premise P2, stating that 'CE is a version of Heraclitism', is false. Nothing in CE forbids us to accept permanently some substantial thesis **U** (3) if this helps to achieve the aim of science (34).

Further, we need to ask whether there is some conception of science explicitly defended by some current philosopher of science that includes Heraclitism. Is there really an 'official ideology' of science that proudly embraces Heraclitism (41)? If there is, then Maxwell has a case against it by means of the first aberrance-argument (18) — charitably glossing over possible qualms about IBE with regard to premise **AccExp** (10). But before it is established beyond reasonable doubt that Heraclitism (41) belongs to the 'official ideology' of science, an attack with the first aberrance-argument will result in a sham fight. This is however not to say that the rejection of Heraclitism (41) by science is not an interesting insight into the nature of science.

4 Exitum: What to Conclude?

Summary. Our overall conclusion is that Maxwell has made it plausible that science permanently *pragmatically accepts* a thesis about the universe (as Lemma I (11) says), namely that the universe is *comprehensible*, *i.e.* is such that it makes every aberrant theory false; this thesis **U** (3) is substantial (Lemma II, (16)) in that it helps science considerably to reach its epistemic aim (15); but thesis **U** is *not metaphysical* (17), because it carries loads of precise empirical content or is at least vulnerable to the results of empirical inquiry. Thus Maxwell has failed to make plausible *Maxwell's Thesis*, which is premise P1 of his Argument (Section 1) against Standard Empiricism (SE), and is the purported consequence of Lemma I (11). Hence Maxwell has also failed to make a case against Constructive Empiricism (CE) *if* CE had been a version of SE. Both 'aberrance-arguments' (18) and (31) we have discerned do not establish Maxwell's Thesis (P1). So as things stand, the step to conclusion C1 of the Argument is a *non sequitur*. Moreover, premise P2 of the Argument, asserting that CE is a version of SE, turned out to be false.

The revised versions of SE we have considered also fail. The move from 'bare' to 'dressed' SE did not affect our assessment of premise P1 as being groundless — and hence was of no avail —, and both versions of SE did not turn the false premise P2 into a true one. The further move from 'dressed' to 'revised dressed' SE (dSE* (38)), at last, made CE a version of it (dSE*), and this, in turn, made premise P2 true. But because of the *epistemic* nature of dSE* (due to the phrase "as a part of scientific knowledge"), the aberrance-arguments performed even worse to establish the then needed, stronger, epistemic version of Maxwell's Thesis (P1), now to be formulated in terms of 'accepting a thesis *as part of our scientific knowledge*'. One reason is that Inferences-to-the-Best-Explanation (IBE) were needed to establish an epistemic version of Lemma I (now asserting that science counts thesis **U** to belong to our *scientific knowledge* of the universe), which is a type of inference that has been severely criticised by Van Fraassen and is definitely not part of CE — ironically, Maxwell rejects IBE too.

Lessons. Does Maxwell's attack, then, has taught us nothing valuable at all? Not so. We have learned the following four lessons.

I. Science acts scrupulously in accordance with the methodological rule 'reject aberrant theories and accept only regular ones' (2) and therefore pragmatically accepts a very general methodological assumption about the universe, namely thesis **U** asserting that all aberrant theories are false (3).

II. Bare Standard Empiricism (SE) is a false conception of science because of its false conjunct SE2 (1).

III. Constructive Empiricism (CE) can accept thesis **U** (3) and can justify this accep-

tance, first, by pointing out that following the associated methodological rule (2) helps science significantly to achieve its epistemic aim, which is the construction of empirically adequate theories (34); and, secondly, by arguing on the basis of CE's libertarian view of rationality that it is *irrational* to reject **U** (3) and act accordingly.

IV. CE can even believe that thesis **U** (3) is empirically true and can count thesis **EmpU** (4) to our scientific knowledge of the universe (in CE's sense of about actual observables only), because **U** boasts with precise empirical content and so far has survived every experimental test.

Perhaps these four lessons I-IV offer but cold comfort for Maxwell, in particular in the light of his Mission Destroy of CE, which has not been successful. We value these lessons, because they have enhanced our understanding of both science and CE.

Acknowledgment
Warm thanks to N. Maxwell for exhaustive discussions (electronic and otherwise), to B.C. van Fraassen for his encouragement to publish the current defense of Constructive Empiricism, and to J.N. Butterfield and D.G.B.J. Dieks for helpful comments and discussions.

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