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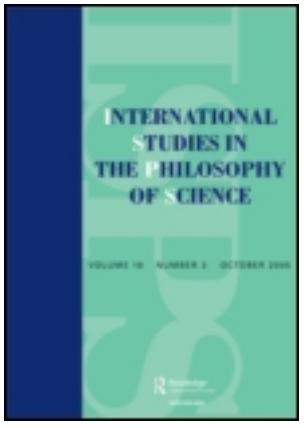

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The Challenge of Scientific Revolutions: Van Fraassen's and Friedman's Responses

Vasso Kindi

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This article criticizes the attempts by Bas van Fraassen and Michael Friedman to address the challenge to rationality posed by the Kuhnian analysis of scientific revolutions. In the paper, I argue that van Fraassen's solution, which invokes a Sartrean theory of emotions to account for radical change, does not amount to justifying rationally the advancement of science but, rather, despite his protestations to the contrary, is an explanation of how change is effected. Friedman's approach, which appeals to philosophical developments at a meta-theoretical level, does not really address the problem of rationality as posed by Kuhn's work. Instead of showing how, despite revolutions, scientific development is, indeed, rational, he gives a transcendental account of rational scientific progress.

1. Introduction

Ever since T. S. Kuhn published *The Structure of Scientific Revolutions* (Kuhn 1970 [1962]), the typical response of philosophers, historians, and scientists alike was centred on showing that his account of scientific development, which involves radical breaks between incommensurable paradigms, was glaringly mistaken. It was repeatedly pointed out by many scholars that, revolutions notwithstanding, there are elements of continuity between successive paradigms and neutral, if not objective, criteria of evaluation that together guarantee the rationality of scientific progress. This approach, which was partially adopted even by Kuhn himself in some of his later writings in a desperate effort to meet his critics halfway,[1] was responsible for casting doubt on the value of his work in general and for casting it out of philosophy of science proper.[2]

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In a surprising reversal, however, two of the most important contemporary philosophers of science, Bas van Fraassen and Michael Friedman, in *The Empirical Stance* (van Fraassen 2002) and *The Dynamics of Reason* (Friedman 2001), respectively, assume a different attitude towards Kuhn. They endorse his claims about scientific revolutions and incommensurability and they agree with him that what we normally take to be rational progress in science is only a retrospective affair i.e., it is a judgement formed after the new paradigm has prevailed. Van Fraassen and Friedman take very seriously the challenge to scientific rationality posed by radical conceptual breaks and, rather than moving to erase the problem by denying that discontinuity is ever radical or real, they undertake to address the issue head-on and make it the centre of attention. Their responses differ significantly but their concern is common: to account for the rationality of scientific development, which they acknowledge and defend just as Kuhn did, given the scientific revolutions. More specifically, they are concerned to make sense of the so-called prospective rationality, i.e., how proponents of an old framework come rationally to adopt an, as yet, unintelligible contender. They expect that by understanding prospective rationality they will avoid the bias attached to retrospective rationality and will be able to vindicate an independently assessed rationality of scientific progress.

Because these two notable contributions not only profoundly refresh the debate regarding the rationality of scientific development in the wake of Kuhn's work, but also share specific elements and concerns, I propose to consider them in turn in order to assess whether they succeed in answering what has been received as the Kuhnian challenge. I will concentrate on what the two philosophers say in their respective books, *The Empirical Stance* and *The Dynamics of Reason*, and invoke the rest of their work, should it impinges upon the particular issue considered. I will begin with van Fraassen's account, which I will criticize, and continue similarly with Friedman's. I will close with some concluding remarks.

2. Van Fraassen: Revolution as Trauma

In his book, *The Empirical Stance*, van Fraassen writes:

> Around the middle of the twentieth century our view of the empirical sciences began to shift. ... Thomas Kuhn introduced his picture of long periods of normal, paradigm-dominated science separated by revolutions. Even that may sound rather sanguine now. In the sciences we see a large human predicament mirrored: epistemic trauma and crisis in science mirror our evolution through many histories of crisis and trauma. ... This phenomenon of our cognitive life poses a major problem for philosophy. In retrospect, we can see the changes we went through—from suffering through reversal to recognition, to use the Aristotelian phrase—as fortunate. But was trauma overcome by reason or by lucky epistemic mutation? (van Fraassen 2002, 65–66)

The trauma referred to by van Fraassen is the breaching of the continuity which features prominently in the rhetoric about science and reason. This rhetoric, 'this triumphalist autohagiography of Reason' (van Fraassen 2002, 73), denies that there can ever be any genuine change of course in the development of science. It certainly

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admits that there are upheavals, even revolutions in its history, but considers them necessary adjustments in the march towards truth. Despite disruptions and disturbances, which are attributed to reaction to past error, the idea is that truth prevails, securing the continuous accruement of scientific knowledge. According to this view, science progresses steadily on the firm base of experience, cutting through prejudices, muddles and errors, and attains truth using the scientific method. In that sense, scientific revolutions do not pose a problem to philosophy. They are seen as grand-scale events which put science on the right track. However, once historians of science, who have not succumbed to hagiography, lay open another possibility, namely, the possibility of radical change of course which does not guarantee the unproblematic accumulation of truths in science, then philosophy is faced with the following problems. According to van Fraassen, in the 'royal succession in science' (van Fraassen 2002, 112), the pretender to the throne, that is, the new theory, appears as 'literally absurd, incoherent, inconsistent, obviously false, or worse—meaningless, unintelligible—within the older view' (van Fraassen 2002, 72). If this is correct, then two issues need to be addressed: (1) how is something unintelligible ever considered to be an option for scientists to take and (2) in what sense is this option, and the succession of theories that it gives rise to, rational?

The term 'trauma', used by van Fraassen in relation to scientific development,[3] is associated in psychoanalytic theory, according to J. Laplanche and J.-B. Pontalis, with three ideas: 'the idea of a violent shock, the idea of a wound and the idea of consequences affecting then the whole organization' (Laplanche and Pontalis 1973, 466). Freud put it as follows: 'the term "traumatic" has no other sense than an economic one. We apply it to an experience which within a short period of time presents the mind with an increase of stimulus too powerful to be dealt with or worked off in the normal way, and this must result in permanent disturbance of the manner in which the energy operates' (Freud 1976 [1917], 315).[4] Laplanche, elaborating on Freud's theory, says that trauma consists of two moments: 'First, there is the implantation of something coming from outside. And this experience, or the memory of it, must be reinvested in a second moment, and *then* it becomes traumatic. It is not the first act which is traumatic, it is the internal reviviscence of this memory that becomes traumatic' (Caruth 2001). Laplanche provides, further, a spatial model of trauma, complementary to the aforementioned temporal one. According to the spatial model, an outside strangeness pierces, invades, and imposes itself on an enveloped human subject who has to process, translate, and cope with the enigma of the other.

Do any of the elements of the psychoanalytic theory of trauma correspond to the way van Fraassen understands trauma in science? The violent shock, the wound, the strangeness of the invading other and the difficulty of assimilating it within the bounds tolerated by the previous state of affairs, have equivalents in the context of science. The new theory, unintelligible and enigmatic from the point of view of the status quo, invades the territory of the old theory upsetting entrenched categories and standard procedures. The wound inflicted corresponds to the broken continuity in the development of science and gives rise to questions regarding the rationality of the whole process. The two moments of the temporal model of trauma articulated by

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Laplanche, may correspond, the first, to the shock experienced by the scientists who are confronted with the new theory, while the second moment may be attributed to philosophers who reflect on the ramifications of what has come to pass on the level of scientific practice.[5]

Scientists often report feelings of dissatisfaction and frustration when a new theory emerges but, usually, they leave these feelings behind and move on. As it also happens in ordinary life, they rationalize the new developments and find a way to integrate and frame them. They retrospectively point to ambiguities, limitations and latent presuppositions in the old theories that are seen as blocking the way to the advancement of science and as necessitating the advent of the revolutionary theory. Van Fraassen quotes such a rationalizing story, often found in textbooks:

> Newton did not arrive at Einstein's relativity because, enslaved by old ideas and seeing his own results with myopic eyes, he extrapolated his facts in a biased way. Einstein pointed out how Newton had gone beyond the deliverances of experience, removed Newton's metaphysical additions, and thus made way for the right theory, truly true to experience. (van Fraassen 2002, 141–142)

According to van Fraassen, retrospectively and within science, the transition to a new theory is seen as 'eminently rational' (van Fraassen 2002, 151; cf. xix). One of the reasons is that the new theory is supposed to present an account that will show the continuity in scientific development. 'One of the main credentials for a new theory, offered as rival to an old one, is that it be able to explain and preserve the successes of the old theory' (van Fraassen 2002, 115). Because of that, to scientists who come to endorse the new theory, as well as to students who are educated by studying the historical reconstructions of textbooks, ruptures, and revolutions become invisible.[6]

Philosophers, however, who have been awakened to the reality of revolutions by the historical philosophy of science as practiced by figures such as Kuhn and Feyerabend, revisit the initial shock experienced by scientists and are now troubled, in the second moment, by the ramifications it generates. They undertake to heal the trauma of rationality (why is an unintelligible pretender to the throne of science a rational option for scientists to take?) and need themselves to tell a story that would render rational the development of science through revolutions. Van Fraassen's way to address these problems is to invoke a Sartrean theory of emotions. In van Fraassen's view, giving in to emotions brings about a transformation that allows a previously unintelligible theory to become intelligible and accepted.

> There is a logical gap between the prior and the posterior epistemic states when they differ on what counts as intelligible. Something is needed to play a certain role in the transition … When emotion has the problem-transforming function that Sartre described, it plays precisely that role. Thus Sartre's description gives phenomenological reality to that something. That something is not a postulated hidden variable but something encountered in experience. (van Fraassen 2002, 108)

And later:

> [T]he change that makes change possible goes so deep that it foregoes any prior rationale. It is a change through (some analogue of) emotion, playing the role Sartre described, in which old values and views are let go. (van Fraassen 2002, 151)

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According to Sartre (1977 [1939]), who gives a phenomenological account of emotions against psychologistic and psychoanalytic theories, emotions help us deal with the world. When it becomes too difficult for us to bear or handle it, when our effective action cannot change it, then, as if by way of cutting the Gordian knot (Sartre 1977 [1939], 45), emotions take over and transmute the world. As they surge through us, the world and our perception of it change. We apprehend qualities we were not aware of before, qualities that we confer upon things magically (Sartre 1977 [1939], 65–66). A key idea in this phenomenological account of emotions is that they are not facts, but, as part of the human consciousness, they signify, they are directed to something outside consciousness and, in that sense, they are functional and teleological. This is the aspect of emotions that van Fraassen mostly wants to appropriate. He needs emotions to account for the conversion experience scientists undergo when they are confronted with the unintelligible rival of the status quo, but he does not need a mechanical, causal account of their function. He needs, what he calls, a cognitive account of emotions (van Fraassen 2002, 104). The appeal of Sartre's account of emotions, van Fraassen says, is the following:

> We have a sense of explanation because we automatically hear the theory as asserting that the new behavior (as well as the giving way to certain feelings) is adopted in order to solve the person's problem, in order to provide a way of responding to the situation that does not make the same impossible or unbearable demands. This 'in order to' makes it not a mechanistic but a teleological account that points to purpose and function. ... This is not a causal account. That I see him as thus or so, and that I am angry at him, are not two distinct facts, they are inextricable. ... To become angry means to come to see things in a different way, as unjust, as deserving of violence and rejection. 'Anger' is a term in person-discourse, not in physics or physiology. (van Fraassen 2002, 103–104)

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3. The Explanatory Value of Emotions

Van Fraassen distinguishes between a causal-mechanical account that is appropriate for the level of physics and physiology, and a cognitive, teleological account that is appropriate for the level of behaviour. He, further, rejects the causal-mechanical account as inadequate to explain the behaviour of scientists who are supposed to make a rational decision in view of a new and yet unintelligible paradigm. He says that he favours the teleological explanation that involves the invocation of emotions that are understood as directed to states of affairs in the world. It is not, however, clear how the intervention of emotions avoids being causal in the mechanical sense and, what is more, how this intervention makes the transition from one paradigm to the next rational. If scientists just 'give way to certain feelings', then emotions seem to be functioning mechanically in order to bring about epistemic conversion. Emotions may be understood as connected to the world, but they do not seem to be controlled by the scientists so as to function as reasons that would lead to rational decisions. Emotions are used by van Fraassen to fill the gap between a prior and a posterior epistemic state during a scientific revolution.

Van Fraassen originally presented his account as empirical, as when he said that emotion 'is not a postulated hidden variable but something encountered in experience' (van Fraassen 2002, 108). When, however, McMullin (2007) questioned the empirical adequacy of van Fraassen's schema, van Fraassen recanted; yet he responded with resolve:

> When I first heard McMullin on this issue, I noticed with surprise that I had never stopped to ask myself whether Galileo's or Copernicus's contemporaries had suffered the sort of epistemic despair that I was describing. This is telling, yet I don't take it as a criticism! The actual persons involved may not have been as painfully insightful as a Pascal or Kierkegaard into their own true epistemic condition. If I so depicted them then that, I admit, was a literary conceit. The challenge I see to epistemology comes with the absurdity deriving from the logical relationship between the old, replaced theory and the new one that replaced it. It is not so surprising —and perhaps even for the best!—if the actors involved in the revolution lack a clear understanding of those logical relations. (van Fraassen 2007, 349–350)

Here van Fraassen insists that there is a logical gap between the old and the new theory, which is bridged by the intervention of emotions. Although he initially maintained, as we saw, that this is something encountered in experience and not something conjured up by philosophers, he later shrugs off McMullin's relevant criticism. Emotions help him tell a story about revolutionary change in science at the philosophical level. Now, if the story were based on empirical evidence, then one would think that it would be more appropriate for a historian rather than a philosopher reflecting *a priori* to do it.[7] If, on the other hand, the story is not empirical, as van Fraassen's considered opinion seems to suggest, then the question is why a philosopher needs to tell such a story. A possible answer is that, in that manner, the philosopher accounts for the transition from one theory to another, which, originally, appears unintelligible; there is a need to understand how this transition is possible. The bridge constructed by the philosopher independently of experience becomes, in this case, a logical requirement. If, however, this is the answer, then, another question emerges: why should the philosopher pick one particular theory, namely, Sartre's theory of emotions, to fill the gap and function as the bridge?

It seems that what van Fraassen finds appealing in the Sartrean analysis, is the cognitive role of emotions, i.e., that they latch upon the world directly and are not just some mechanical push that propels humans into reflection and then action. Once emotions intervene, they bring about a different perception of the world and, *ipso facto*, the transition is effected. The problem for van Fraassen's account, however, is that, according to Sartre, this whole operation takes place on the non-reflective level of consciousness (Sartre 1977 [1939], 58–59). What is more, the behaviour that follows the manifestation of emotion is characterized by Sartre as irrational (Sartre 1977 [1939], 67), meaning that it is not the result of reflection. This statement comes in direct conflict with van Fraassen's view according to which 'the term "emotion" taken in Sartre's sense does not, or at least should not, carry connotations of irrationality' (van Fraassen 2007, 350). Van Fraassen chooses the Sartrean theory of emotions because he expects it to help him account for the rationality of scientific progress, but Sartre himself considers the

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ramifications of their function as irrational. Sartre repeatedly compares the function of emotion to magic, a fact that van Fraassen cannot and does not disregard. Van Fraassen explains that he does not buy the whole Sartrean package (van Fraassen 2002, 105). Still, given that he is interested in showing that the transition from an old to a new theory in science is rational, it is not clear how he accomplishes this by appealing to a Sartrean analysis of emotions, even if truncated. Van Fraassen, by referring approvingly to the book *A Tear Is an Intellectual Thing* (Neu 2000), is hinting that he favours an intellectualist or cognitive understanding of emotions (van Fraassen 2002, 104, 246n54). But Neu's analysis does not tally with Sartre's, which is also endorsed by van Fraassen. Neu (2001) maintains that his approach is Spinozist 'in the sense of giving great prominence to the role of ideas, thoughts, judgments, beliefs, and the like, that is to say, the cognitive, in constituting our emotional lives'. He says that 'emotions involve thought, indeed, are themselves a kind of thinking' and endorses the idea that 'reflexive knowledge can have a transformative effect' (Neu 2000, 13). Neu may agree with Sartre that thoughts are not like headaches—they have direction (Neu 2000, 12), he may call Sartre's account of emotion as action (i.e., the action of transforming the world) fascinating (Neu 2000, 26), but he seems to be ignoring Sartre's opposition to the standard idea that any action involves reflection. 'An operation upon the universe is generally executed without our having to leave the non-reflective plane', Sartre (1977 [1939], 58–59) says. Sartre thinks that emotions work magic and transmute the world (Sartre 1977 [1939], 84) while Neu says that reflexive knowledge transforms it.

One may attribute Neu's and Sartre's differences to terminological matters, i.e., how broadly or narrowly they understand thought and emotion. Still, although Sartre says that real emotion is accompanied by belief (Sartre 1977 [1939], 75),[8] there is certainly a difference of emphasis. In talking about emotions, Neu emphasizes thought and reflection while Sartre emphasizes the bodily and non-reflective aspect of them. Sartre considers running from danger 'a magical behaviour which consists of denying the dangerous object with our whole body' (Sartre 1977 [1939], 63) while Neu thinks that running 'need not be a form of denial. It may be an active recognition of danger and an appropriate (not magical) response to it' (Neu 2000, 27). Given these differences between Sartre and Neu on what emotion is, it is not very clear what exactly van Fraassen wants to appropriate from both and how their analyses contribute to keeping revolutionary developments in science within the bounds of reason.

Van Fraassen says that he is not concerned to offer a mechanical explanation, at the level of physiology, regarding the transition from one paradigm to the new, unintelligible challenger. He is interested in offering an explanation of the transition at the level of behaviour and, also, interested in showing that this transition is rational. He thinks that Sartre's theory of emotions will give him the explanation he needs, but I have argued that it is not clear how Sartre's theory, which van Fraassen treats very loosely and in ways that are inconsistent with what Sartre said, will serve his purpose. On the one hand, Sartrean emotions may be seen as mechanical gap-fillers if scientists just give in to them and, on the other, as elements that lend themselves to irrational rather than rational moves. Sartrean emotions may be cognitively connected to the world but, if they are not controlled by the scientists, the emotions cannot justify

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the rationality of moving from one paradigm to its rival. Scientists may aim to confront the strange and unintelligible pretender to the throne of science and, therefore, develop the feelings that will help them deal with it, but if they do not control their behaviour, it cannot be said that they are making a rational decision. A teleological explanation, i.e., an explanation where goals function as reasons for action, may help to account for rational behaviour, but in van Fraassen's account, emotions just effect change and do not rationally motivate it.

It may be said that, given van Fraassen's lax understanding of rationality (rational permission rather than rational compulsion),[9] he is not interested in justifying philosophically the rationality of scientific development; he is only interested in showing that the change effected by emotions is rationally permitted. If, the objection goes, rationality is, as van Fraassen thinks, only 'bridled irrationality' (van Fraassen 1989, 172; 2002, 92, 97), and the invocation of emotions to account for the rationality of scientific change is not forbidden by the standards of reason, then van Fraassen does make a case for the rationality of scientific development. I am afraid that this route is not open to van Fraassen. Let's see why. Let's assume, first, that the change effected by the mediation of emotions is not forbidden by reason and so, the adoption of the new paradigm is, by van Fraassen's lights, rational. But many other moves may have been permitted and would have been equally rational, from van Fraassen's perspective. How, then, is the 'post-Kuhnian predicament' answered? Kuhn's critics wanted some assurance that the adoption of a particular paradigm was indeed rational (for instance, that the new paradigm is superior to the old in terms of making true statements, as opposed to the false statements made by the previous theory, that it has more explanatory power, that it makes more accurate predictions, etc.). If other options, besides the one taken, were also rational, how is the particular move vindicated? It seems that van Fraassen's very lax conception of rationality would make any move rational as long as it did not result into an incoherent corpus of beliefs. And this takes us to the second problem. The bridles or criteria of reason involve logical considerations. Epistemic rationality requires, according to van Fraassen, coherence, even if broadly construed (van Fraassen 2007, 351–355). This means that in order to proclaim the transition from one set of beliefs to another rational, we need to be able to assess relations of coherence between beliefs. But either this is a retrospective affair (i.e., a retrospective vindication of the decision taken by the proponents of the anterior paradigm), in which case we do not have the much desired account of prospective rationality (van Fraassen 2002, 92), or no relations of coherence can be established since the rival paradigm strikes the scientists who are called to decide as utterly absurd and unintelligible, and as such, cannot stand in logical relations, even if lax, to the old. Van Fraassen recognizes this himself when he says that we cannot fit the decision to convert into our familiar pattern of rational decision: 'For in that pattern the relevant parameters are the probability and value assessments possessed prior to the decision, which are the embattled factors at that point' (van Fraassen 2004, 129; cf. 2007, 350).

This thought is used by van Fraassen to advocate voluntarism, an epistemology which stresses the role of the will, commitment, and of 'ineliminably subjective choices' in adopting or changing a belief (van Fraassen 2004, 129), much in the

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spirit of William James's 'The Will to Believe' (James 1977 [1896]). But even this kind of epistemology, van Fraassen admits, with its attendant conception of permissive rationality, 'does not by itself suffice to answer the question about the rationality of scientific revolutions'. 'For how could a person's or a community's commitment to a certain epistemic policy allow for a change in any of the parameters that identify that policy?' (van Fraassen 2004, 130).

So the objection that says that van Fraassen favours a permissive rather than a compulsive conception of rationality, and so cannot be criticized for not offering a justification for the rationality of revolutionary transitions is, I think, off the mark. He says himself that his conception of rationality[10] is not sufficient to guarantee that the radical transitions are rational even by his own very permissive lights. That is why he needs to invoke the Sartrean emotions, a move which much resembles giving a causal explanatory account instead of a justificatory one.

A further problem with the Sartrean account van Fraassen invokes is the following: Sartre says repeatedly that emotions transform both the subject and the world: 'since the seizure of one object is impossible, or sets up an unbearable tension, the consciousness seizes or tries to seize it otherwise; that is, tries to transform itself in order to transform the object' (Sartre 1977 [1939], 63; cf. 84, 88). Van Fraassen, however, concentrates mainly on the change on the subjective side, disregarding or downplaying the change on the part of the world. He says, for instance, that the role that Sartre ascribed to emotion is 'the role of changing the decision situation itself on the subjective side' (van Fraassen 2007, 350) and that 'on Sartre's account, the central factor in emotion is a certain kind of change in view that transforms our subjective situation' (van Fraassen 2002, 104). Does van Fraassen accept Sartre's view about the transformation of objects in the world? If the answer is 'yes', then he needs to explain how the resulting incommensurability in ontology is accommodated within the account of rationality that van Fraassen seeks to construct through the use of the Sartrean emotions. If, however, the answer is 'no', then there is one more reason to question the suitability of the Sartrean analysis for van Fraassen's project.

Finally, let us consider again how van Fraassen describes the problem he undertakes to solve. In his view, a new theory challenges the reign of the old, but it is, by the old theory's lights, absurd and unintelligible. The question then is how the new theory ever becomes an intelligible, and what is more, a rational option. Van Fraassen, as a philosopher, introduces the conversion parameter in the description of the problem situation and fetches emotions, cognitively understood, as the catalyst that brings about rational progress. One problem that we have already noted is that this appeal to emotions makes the account explanatory rather than justificatory, however permissively we understand rationality. Another problem is whether, indeed, scientists are ever confronted with an unintelligible paradigm and have to develop the relevant emotions to convert. Historians may challenge van Fraassen's description of the situation. McMullin, for instance, talking about Galileo's revolution in mechanics, maintains that 'there is no indication anywhere in the story of a moment of crisis where progress was blocked because of the apparent absurdity of the next step. In fact, this particular revolution was never all-or-nothing. It was always a matter of incremental

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steps, achieving empirical results as well as devising mathematical analysis, with no clear picture at any stage of a choice between two well-defined alternatives' (McMullin 2007, 173).

If things are as McMullin describes them, what is the basis for van Fraassen's formulation of the problem? How does he come up with the idea of a stand off between two rival theories, one, at least, of which—the new one—is unintelligible to the other? I think that van Fraassen's schema originates from a particular philosophical understanding of things, i.e., from an abstract and *a priori* perspective which sees concepts as well defined and ring-fenced and theories as well-circumscribed entities run through by a vein-like set of categories which do not correspond to the categories of the other theory. They are unintelligible to each other since they do not match, and if circumstances turn them into rivals, then, there need to be found a way so that a transition from one to the other becomes possible. The new theory is not seen as triggered from behind, in Kuhn's terminology, i.e., from problems confronted in the practice of normal science, but as an alien entity emerging in the horizon as from nowhere. Van Fraassen is not interested in how things have actually happened, but in the logical relations of theories, a domain which requires the handling of closed entities, with all the problems that ensue. He recognizes the impasse himself and calls for 'a more nuanced account of our doxastic and epistemic life' (van Fraassen 2004, 130), one that makes room for equivocation, ambiguity and vagueness.

> To accommodate the sort of dangerous, adventurous, tumultuous epistemic life we actually lead, we need a different way to think about our language, about the opinion we express in that language, and about the assessment of how we change that opinion. (van Fraassen 2004, 131)

Van Fraassen seems torn between responding to the intellectualist demand of answering the Kuhnian challenge formulated by traditional epistemology, and the voluntarist indulgence in permissiveness. The account he gives, which involves the invocation of Sartrean emotions, is either explanatory (which he denies, saying that it is not empirical and he does not offer causes for change of belief) or, else, a story that, as a philosopher, he feels the need to tell.[11] The intellectualist demand tells him that there is a revolutionary gap to be filled and he finds emotions to fill it. It seems, however, that anything would do since he says that he understands Sartre's emotions 'in a very general sense' (van Fraassen 2004, 130). He says that 'whatever we put in place to characterize such radical doxastic transition' will rightfully be called emotion and do the job.

4. Friedman: The Mediation of Philosophy in Revolutionary Transitions

In his book *Dynamics of Reason* (2001), Friedman, like van Fraassen, undertakes to show how the revolutionary transition from a theory to its rival is not just possible, but also rational (cf. Friedman 2008a, 249). Kuhn had tried to respond to the charges of irrationality and conceptual relativism levelled against his account of non-cumulative scientific development by invoking the standard list of criteria (accuracy, precision, consistency, simplicity, fruitfulness, and the like) which, functioning as

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values, are supposed to govern the puzzle-solving activity that is characteristic of science. These criteria, Kuhn maintained, being permanent and shared by scientists across fields, guarantee the rationality of scientific progress both within and across paradigms (Kuhn 1977, 335). Friedman, however, claims that Kuhn's attempt fails for three reasons (Friedman 2001, 51–53). First, Kuhn's own historiography helps raise doubts as to whether such criteria are actually shared and permanent across revolutionary scientific change. Second, even if these criteria were indeed permanent, there would still remain the question of how we would be able to inter-paradigmatically assess the satisfaction of these criteria since there is no paradigm-independent platform of evaluation. Third, even if both previous points are granted, we can still remain sceptical as to whether there exists a permanent and universal human rationality captured by this fixed list of standards. So, Friedman sets out to provide a different, vindicatory account of scientific rationality in periods of revolutionary change.

Using the distinction between *instrumental* and *communicative* rationality made by Jürgen Habermas, Friedman suggests that Kuhn abandons instrumental rationality as a means of rebutting his critics on the issue of conceptual relativism, in favour of preoccupying himself with problems that relate to communicative rationality. Instrumental rationality refers to our capacity to adjust means and ends whereas communicative rationality aims at bringing about consensus of opinion by appealing to patterns of argument acceptable to all parties in a dispute. According to Friedman, Kuhn's standard criteria of puzzle solving can secure rationality only instrumentally, whereas the question to be addressed is how the transition from one paradigm to another, from one constitutive framework to another, can be communicatively rational.

Friedman divides the problem in to two parts: the transition ought to be rational, he says, both retrospectively and prospectively. Retrospectively, one can speak of inter-framework or inter-paradigmatic convergence. This is not a realist convergence to how the world really is, but a communicative one. The later framework is seen as expanding the space of empirical possibilities of the earlier and containing the latter as an (approximate) special case (Friedman 2001, 96). Friedman, though, is very careful to point out that the later framework is seen as rationally superior to the earlier, only from the point of view of the later framework. The old framework is reconstructed from within the new framework, found wanting, and allocated a special place. Yet, the gist of the problem as regards conceptual relativism, Friedman admits, is not retrospective rationality. Once a constitutive framework[12] is in place, we can see that it is an improvement over the one it replaces. The difficult thing is to explain, *prospectively*, how the new framework becomes a rational, a 'live', option.

The term 'live option' is reminiscent of the term 'living option' used by James in his essay, 'The Will to Believe'. A 'living option' for James is a choice between 'live hypotheses', i.e., hypotheses that present real possibilities to those to whom they are proposed. For instance, the choice between being politically a liberal or a conservative is a *living option* for citizens in Europe these days because both alternatives are appealing in certain respects, whereas the choice between believing in Zeus and believing in Isis is a *dead option* since neither suggestion can motivate us to act; both seem irrelevant. The point of James's essay is to argue that when we have issues to decide we should not

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wait indefinitely for coercive evidence and final proof but we should 'run the risk of acting' (James 1977 [1896], 732). We should not ignore our passionate nature waiting for some intellectual resolution that may never come. If we had an infallible intellect, James says, we would be perhaps justified to wait for its 'releasing word'. 'But if we are empiricists, if we believe that no bell in us tolls to let us know for certain when truth is in our grasp, then it seems a piece of idle fantasticality to preach so solemnly our duty of waiting for the bell' (James 1977 [1896], 734). It is better, James maintains, to risk a choice, to take life in our own hands, to trust our inclinations and desires rather than suspend action.

Friedman's 'live option' is very similar in name to James's 'living option' but it differs from it in several respects. Friedman's 'live option' could be seen as being closer to James's 'live hypothesis' rather than to James's 'living option' since what interests Friedman is when a given paradigm becomes a real possibility—a live hypothesis—for scientists immersed in a previous tradition. A real possibility for Friedman amounts to a rational possibility, i.e., to conditions that make a given paradigm a *rational choice*. Unlike James for whom a 'living option' is a choice between two 'live hypotheses', both of which make an appeal to our belief, Friedman seems to imply that once a paradigm becomes a 'live option', i.e., it is prospectively rational, then the rational thing to do is to adopt it. Sticking to the old paradigm would be a real possibility (in James's sense), but it would not bring science forward; on the contrary, it would be a retrogression. Friedman is interested in securing rational scientific progress and makes his assessment from a philosophical perspective, searching for communicative rationality. James is focusing on the individual and is interested in legitimizing the individual's passionate side in decision-making. Friedman's concern is intellectualist and collective, if not impersonal; James's, individualistic and practical.[13]

Friedman develops his project in three steps or on three levels. In order for a paradigm to be a live option, it should, first, present, retrospectively, i.e., from a point of view internal to the development of the sciences, earlier frameworks 'as limiting cases, holding approximately in certain precisely defined special conditions' (Friedman 2001, 66; cf. van Fraassen 2006, 298). Second, from a historical perspective, the concepts and constitutive principles of later paradigms, i.e., the *a priori* but not unrevisable fundamental propositions of a framework, should 'evolve continuously, by a series of natural transformations, from those of earlier ones' (Friedman 2001, 66), even if successive paradigms are seen as incommensurable or non-intertranslatable. Third, from a philosophical point of view, 'this process of continuous conceptual transformation should be motivated and sustained by an appropriate new philosophical meta-framework, which in particular interacts productively with both older philosophical meta-frameworks and new developments taking place in the sciences themselves' (Friedman 2001, 66). This new philosophical meta-framework 'helps to define what we mean, at this point, by a natural, reasonable or responsible conceptual transformation'. According to Friedman, philosophy makes revolutions in science possible by conceiving of and presenting new conceptual possibilities (for instance, the relativized conception of time).

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> Science, if it is to continue to progress through revolutions, therefore needs a source of new ideas, alternative programs, and expanded possibilities that is not itself scientific in the same sense—that does not, as do the sciences themselves, operate within a generally agreed upon framework or taken for granted rules. For what is needed here is precisely the creation and stimulation of new frameworks or paradigms, together with what we might call meta-frameworks or meta-paradigms—new conceptions of what a coherent rational understanding of nature might amount to—capable of motivating and sustaining the revolutionary transition to a new first-level or scientific paradigm. (Friedman 2001, 23)

Friedman maintains that that is how philosophy has functioned in the past and that is how it should function. Different views and different traditions within philosophy do not present a problem because, first, he needs a 'relatively weak' consensus—'we require only that the new constitutive framework become a reasonable and responsible live option' (Friedman 2001, 107), second, he believes that there is a relatively stable consensus as regards the important contributions to what is debated even though there is rarely a consensus as regards the results, and third, he expects philosophy, even with 'controversial and conceptually problematic philosophical themes' to prepare the way for a new scientific paradigm by mediating between 'relatively uncontroversial and unproblematic areas of scientific reflection' (Friedman 2001, 107).

Friedman also maintains that we must view our present community and the consensus it has reached regarding our present constitutive principles as an approximation to a Peircean-like ideal community acknowledging ideal standards of universal, transhistorical communicative rationality. 'For only so can the required inter-paradigm notion of communicative rationality be sustained' (Friedman 2001, 65). Friedman, clearly and explicitly, describes a Kantian-like project:

> What I am now suggesting is that we should adapt Kant's conception of the regulative use of reason to what he called the constitutive domain as well—so as to attain, in particular, an inter-paradigm, trans-historical universality within *this* domain. (Friedman 2001, 64)

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5. Friedman Is to Kuhn What Kant Was to Hume

As we have seen, Friedman proposes that Kant's conception of the regulative use of reason be *adapted* to what Kant called the constitutive domain. It's not very clear what Friedman means by this. In Kant's system, reason generates *a priori* principles and ideas (e.g. manifoldness, affinity, unity) to serve the interests of reason: for instance, to give our empirical knowledge systematic unity. These ideas and principles, clearly, do not enter into the constitutive domain for fear that they will come into conflict and generate inconsistencies; they remain subjective, even if they seem objective (Kant 1990 [1787], A666/B694). They are maxims prescribing that we regard the method of looking for order in nature 'as grounded in nature as such' (A668/B696). They do not tell us how the objects are constituted but how, under the guidance of these maxims, 'we should seek to determine the constitution and connection of the objects of experience' (A671/B699).[14] Friedman, however, does not merely want to regard science *as if* it developed rationally (something that would be comparable to

Kant's project); he wants to argue instead that science *does* develop rationally through revolutions.[15]

In a certain sense, one might say that in Kant, the regulative ideas of reason are already 'applied' or 'adapted' to the constitutive domain. In Friedman's own words: 'the regulative procedure of reflective judgment functions always for the sake of the constitutive demands of the understanding' (Friedman 1991a, 90). But Friedman appears to be asking for something more when he invites the regulative use of reason in the constitutive domain of science. How are we to understand this? The regulative operations serve particular purposes in the Kantian system and architectonic: under their guidance empirical concepts and laws are progressively unified in order that they converge to an ideal complete natural science. In Friedman's account, where radical upsets brought about by scientific revolutions are recognized and even thought to be necessary (Friedman 2001, 64), how can such an operation be accommodated? How can incommensurable concepts converge to a common ideal? It seems that Friedman is following Cassirer's and the Neo-Kantian Marburg School's genetic and teleological conception of knowledge,[16] which Friedman himself has so thoroughly analyzed, a conception according to which the Kantian constitutive a priori *is absorbed* into the regulative a priori (Friedman 2000, 117, 123, 145). But, as Friedman explains, Cassirer is also committed to 'the originally Leibnizean ideal of a truly universal, trans-national, and trans-historical system of communication, exemplified by the logical-mathematical of exact scientific thought' (Friedman 2000, 153). Is Friedman equally committed to such an ideal? In a way he is: he speaks, as we have seen, of an inter-paradigm, trans-historical universality within the constitutive domain. The problem is that this view is not easily reconciled with the thesis of incommensurability, which Friedman also accepts. He says that, like Cassirer, he does not care about ontology, and in that sense he is in disagreement with Kuhn whom he credits with an ontological or substantialistic understanding of scientific development.[17] Friedman maintains that his own argument for conceptual incommensurability 'relies on precisely the Kantian distinction between logical and real possibility—which thereby replaces Kuhn's concern with "physical referents"' (Friedman 2008a, 249n25). But given that the Kantian real possibility, as interpreted by Friedman himself, 'most closely corresponds to our notion of "physical possibility"' (Friedman 1985, 504n69)—it involves, that is, empirical intuition—how is Friedman's suggestion different from Kuhn's? '[N]ecessary presuppositions for empirical application and meaning is just my replacement for Kuhn's appeal to "physical referents"', says Friedman (2008a, 251n30). I understand that Friedman wants to avoid ontology and preserve continuity at the conceptual level. But if the necessary presuppositions involve concepts that are incommensurable, then it is difficult to see where the continuity lies. If, on the other hand, the necessary presuppositions are not incommensurable, then, where does incommensurability feature?

We said earlier that Friedman wants to show that science *does* develop rationally through revolutions. How does he do that? It appears that he is speaking generally but, in fact, I think, Friedman's point is basically historical.[18] What he says is that science, with the help of philosophy, *has indeed developed* rationally through revolutions[19] and the example that most perfectly suits his case is Einstein's theory of

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relativity. This theory became mathematically and physically possible, according to Friedman, by 'the actual historical conceptual evolution' (Friedman 2008a, 251) of the period. This conceptual evolution involved, on the one hand, mathematical and physical developments (the development of non-Euclidean geometries, the discovery of the constancy and invariance of the velocity of light, etc.) and on the other, 'a set of parallel developments in contemporaneous scientific philosophy to tie together the relevant innovations in mathematics and physics and thereby effect the necessary expansion in our physical or empirical possibilities' (Friedman 2008a, 250). Kant's original system was reconfigured to accommodate developments 'in both post Kantian scientific philosophy and the sciences themselves' (Friedman 2008a, 252).

Several things can be said here:

1. If Friedman's argument regarding the rationality of scientific development is historical, then, at least in principle, one may give a different account of historical events which would not lay, for instance, so much emphasis on the contribution of philosophy in periods of transition either in the particular case of the theory of relativity or in general.[20]
2. If the argument is not historical, then Friedman's suggestion seems to imply that we would always need a specific kind of scientific philosophy working parallel to the sciences so that the latter's conceptual possibilities are expanded. But why should the conceptual possibilities needed by science be provided only by scientific philosophy? Can't other disciplines, within or outside the humanities, as Friedman (2001, 23) himself recognizes, function in a similar way? Can't the sciences themselves do the job? One may even argue, in agreement with Wittgenstein, that the case is the other way around: it is the sciences that show possibilities to philosophy: 'Is scientific progress useful to philosophy? Certainly. The realities that are discovered lighten the philosopher's task, imagining possibilities. Realities are so many possibilities for the philosopher' (Wittgenstein 1982, §807 and note).[21]
3. Is the rationality of scientific development specifically tied to the involvement of scientific philosophy? If the expansion of possibilities is offered by other disciplines, would we still talk of rational progress in science? Is there a prejudice, that is, in favour of philosophy as regards rationality?
4. Presumably, the scientific philosophy, of which Friedman speaks, would have to follow what is going on in the sciences, which means that it would be possible for scientists to consult it at any time. In that case—that is, in case philosophy and science are seen as working together—would it be possible to have revolutionary breaks in scientific development? Wouldn't scientific philosophy be always there to resist ruptures of rationality?
5. Friedman's contribution to the study and re-evaluation of logical positivism cannot be overestimated. In the introduction to his book *Reconsidering Logical Positivism*, he says that 'the initial impetus for [the logical positivists'] philosophizing came from late nineteenth-century work on the foundations of geometry by Riemann, Helmholtz …' (Friedman 1999, 6). Earlier, Friedman attacked the stereotype that viewed logical positivism as providing foundations for the sciences.

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> On the contrary, he said, according to the logical positivists, and more particularly Schlick, 'it is the special sciences that are foundational for philosophy' (Friedman 1991b, 508). Schlick thought, Friedman says, that both Cassirer's Neo-Kantianism and Mach's positivism ought to be abandoned because none could do justice to Einstein's new theory. 'Entirely new philosophical principles—based on Einstein himself and on Poincaré—are necessarily required' (Friedman 1991b, 508). If this is correct, then it seems that philosophy takes its cue from the sciences in order to undergo itself a reconceptualization or a revolutionary change.[22] How, then, is philosophy supposed to guarantee the rational advancement of science, as Friedman described it, when there is such a two-way traffic between the two domains, the scientific and the philosophical?

Friedman is undertaking a transcendental project: how is the rational advancement of science possible given deep ruptures in its development? His answer in *Dynamics of Reason* is that developments in philosophy disclose and present new possibilities to the particular sciences, possibilities that are *ipso facto* rational live options. In his later papers, he more explicitly envisions a continuation of Kant's transcendental approach: 'In my reconceived version of transcendental philosophy, therefore, integrated intellectual history of both the exact sciences and scientific philosophy takes over the role of Kant's original transcendental method' (Friedman 2008b, 99; cf. 106–107). He calls his project a 'historicized version of transcendental philosophy' (Friedman 2008b, 112; cf. 2008a, 251) but he says that he overcomes contingency by drawing attention to an 'inner logic' in the successive intellectual situations, which just as in Kant's case, compels towards 'a practically unique solution' (Friedman 2008b, 98). That is, given the inner logic of what was available, there would be just one outcome. The question is whether this solution, i.e., the unique, universalist account Friedman gives of scientific development, really takes us out of the 'post-Kuhnian predicament'.

Friedman starts from two unavoidable presuppositions: the incommensurability of theories and rational scientific progress. He then asks what makes this development possible. Friedman takes the Kuhnian problem to be a problem of '*understanding* the rationality of revolutionary transitions involving essentially discontinuous or incommensurable scientific paradigms or conceptual frameworks' (Friedman 2008a, 252; my emphasis) whereas, the real Kuhnian problem, as it has been received in the literature and as originally framed, is to show that it is indeed rational. Friedman is to Kuhn what Kant was to Hume.[23] Hume's problem was that we cannot prove that we have empirical knowledge. Kant said in response that we have knowledge and asked what makes it possible in an effort to vindicate it. In a similar manner, I think, Friedman does not give proof that the advancement of science is rational; in the transcendental version of his approach he shows how the rational transitions in science are possible. And in the spirit of Kant, his answer is vindicatory and universalist.[24]

The same transcendental and universalist strategy is illustrated in the invocation by Friedman of Habermas's concept of communicative rationality. Friedman rejected Kuhn's attempt to bridge the gap of revolutionary breaks by appealing to common

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values as falling under instrumental rationality, that is, where there is agreement on ends and means, and suggested, instead, that we make use of Habermas's communicative rationality which is supposed to be operative where there is disagreement and dispute. But could communicative rationality really help us out of the Kuhnian predicament? Habermas's formal pragmatics of communication (which he originally called universal pragmatics) concentrates on the preconditions, or formal principles, of rational dialogue that aims at reaching understanding. These principles, invoked supposedly by every speaker engaged in communicative action (for instance, the truthfulness of the speaker, the truth of the statements made, the rightness of the speech act in a given context), are, according to Habermas, presumably universal 'because they are unavoidable' (Habermas 1998, 22–23, 407).[25] Habermas, that is, begins from understanding and communication and seeks to infer, transcendentally, the presumed conditions of these acts. In the case of scientific paradigms, however, if one accepts the Kuhnian analysis as Friedman does, we seem to lack understanding and communication, we lack the shared universe, the common horizon, the common objective world that Habermas (1998, 315, 418) requires. Habermas rejects the idea of incommensurability[26] and speaks of rationality in the singular (Habermas 1998, 408). How, then, can Habermas prove useful in addressing the issue of rationality in view of discontinuous scientific development? His contribution is only transcendental. We were expecting that communicative rationality would help us bridge the rationality gaps that are associated with revolutionary breaks in the sciences but what we have instead is the laying out of supposedly universal principles which presumably make communication and rationality possible.

Habermas's formal presuppositions of communication have themselves been criticized as not being so formal after all. It has been said that Habermas proclaims as universal purely Western liberal principles. Thomas McCarthy (2009), for instance, speaks of 'liberal imperialism' and claims that the unity of reason in the diversity of voices is something to be achieved, not something given, while Raymond Geuss points out that some, at least, of Habermas's preconditions are very recent Western inventions (Geuss 1981, 65–67).[27] So, it seems that Habermas cannot really help us address the difficulties that were presented to us by Kuhnian and post-Kuhnian historiography. Even if his analysis is taken to offer a solution, this 'solution' is either only formal and, thus, too abstract and too weak to enter into the constitutive domain that interests Friedman or not really formal and thus not as universal or objectively rational as Friedman would have liked.

In the *Dynamics of Reason* the transcendental character of Friedman's analysis is not so prominent. There philosophy, as a meta-framework, is assigned a more interventionist, one might say foundationalist,[28] role. But, then, van Fraassen's complaint becomes pertinent: 'Friedman, I think, is swayed by the conviction that theoretical transitions, including the most revolutionary, must be guided by *a priori* principles at a meta-theoretical level. To an empiricist this must be ruefully classed as of a piece with other general convictions deriving from the metaphysical instinct—admittedly an instinct that has been regrettably common also in empiricist ranks … This instinct has here retreated to a meta-theoretic level, but is otherwise unchanged'

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(van Fraassen 2006, 303). One does not need to invoke empiricism in particular as van Fraassen does; one might ask, in general, why philosophy needs to play this justificatory role.

6. Conclusion

Both van Fraassen and Friedman, responding to the Kuhnian challenge of rationality, envision a justificatory mission for philosophy.[29] They address a similarly described problem situation, namely, a stand-off between two rival and incommensurable frameworks separated by a logical gap, which needs to be rationally filled. Philosophy, in both cases, is commissioned to help by showing where the rationality of scientific progress lies. In Friedman's case, philosophy assumes itself the active role of bridging the rationality gap, with all the concomitant problems noted, while van Fraassen needs philosophy to lead him to discover the instrumental role of emotions. Both answers illustrate, however, how difficult it is to satisfy the intellectualist demand of justifying rational progress. Before van Fraassen and Friedman, philosophers were in denial as regards discontinuity and radical conceptual transformation. The two thinkers advanced the debate by acknowledging a salient feature of science's history, namely, radical scientific revolutions, but their answers are still caught in the traditional epistemological framework they seek to overcome. Friedman's historically informed approach is vindicatory and intellectualist even if transcendental; van Fraassen's voluntarist and, in that sense, more appreciative of the impasse and more in line with James's proposal which encourages choice even in the absence of compelling proof. Still, given that the two philosophers do not distance themselves from the way rationality has been traditionally understood and given that the problem they undertake to address is rationalistic in character (i.e. it aims to provide philosophical justification for the rationality of scientific development), one feels that the answers do not succeed in getting us out of the 'post-Kuhnian predicament' they describe.

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Notes

[1] I am referring to his suggestion that incommensurability is not global but only local or that there are certain values shared across revolutions by all scientific communities, or that the puzzle-solving ability is increasing with time across paradigms. All these elements are supposed to guarantee rational scientific progress.

[2] Kuhn's work, which has been seen as having only historical value, has been relegated to the margins occupied by the so-called historical philosophy of science.

[3] Van Fraassen uses the term 'epistemic trauma' drawing on the use of the same term by Vargish and Mook (1999). See van Fraassen (2002, 67 and 239n5).

[4] See Laplanche and Pontalis (1973, 465): 'In economic terms, the trauma is characterized by an influx of excitations that is excessive by the standard of the subject's tolerance and capacity to master such excitations and work them out psychically.'

[5] If van Fraassen's account places the two moments of epistemic trauma in two distinct communities, that of the scientists and that of the philosophers, then it lends emphasis to the distinction made in much work in science studies today, namely, that between issues that concern the analysts and those that concern the scientists in their practice.

[6] Cf. Kuhn 1970 [1962], ch. 9, titled 'The Invisibility of Revolutions'.

[7] Here, I don't consider the possibility of a philosopher doing empirical work since van Fraassen does not seem to entertain it.

[8] When Sartre talks about beliefs accompanying emotions he wants to stress the pervasiveness and intensity of the emotive stand. When we are overwhelmed with emotion we do not play-act but somatically express our belief in how the world has been transformed. 'Merely to run away from it would not be enough to constitute an object as horrifying. Or rather, this might confer the formal quality "horrifying" upon it, but not the substance of that quality. If we are really to be seized by horror we have not only to mime it, we must be spell-bound and filled to overflowing by our own emotion, the shape and form of our behaviour must be filled with something opaque and weighty that gives it substance. Here we can understand the part played by the purely physiological phenomena; they represent the genuineness of the emotion, they are the phenomena of belief' (Sartre 1977 [1939], 76).

[9] See van Fraassen's distinction between the Prussian and English conception of rationality: 'the Prussian concept of rationality: what is rational to believe is exactly what one is rationally compelled to believe. I would opt instead for the dual [English conception]: what is rational to believe includes anything that one is not rationally compelled to disbelieve' (van Fraassen 1989, 171).

[10] For a discussion of van Fraassen's conception of rationality see Psillos (2007).

[11] It seems that the distinction between the two moments of trauma mentioned earlier, affecting different individuals (the scientist and the philosopher), is relevant after all.

[12] Friedman makes use of Reichenbach's insight regarding revisable *a priori* principles which coordinate mathematical structures and empirical reality and, thus, play a constitutive role in the framework that contains them, i.e. they function as necessary presuppositions of the framework's empirical claims (Friedman 2001, 30, 76–78; 2005, 123–125).

[13] It may be said that the comparison between Friedman and James is not appropriate since James concentrates on religious affairs, where the decisions are momentous, whereas in scientific matters options to choose are never forced. James says, however, that this is '*almost* always the case' (James 1977 [1896], 728; my emphasis) as regards scientific questions. He then goes on to distinguish between the purely judging mind, which can be indifferent and can wait for coercive evidence, and the individuals who are engaged in research. The actual investigators, according to James, are supposed to resort to their passionate nature. '[I]f you want an absolute duffer in an investigation, you must, after all, take the man who has no interest whatever in its results: he is the warranted incapable, the positive fool' (James 1977 [1896], 729). In the cases under consideration, namely revolutionary change in science, we are not dealing with absolute intellects but with real players facing momentous options.

[14] Kant acknowledges that if these ideas and principles are to have 'the least objective validity', if they are not to be 'mere empty-thought entities (*entia rationis ratiocinantis*), a deduction of them must be possible, however greatly (as we admit) it may differ from that which we have

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been able to give of the categories' (Kant 1990 [1787], A670/B698). He, then, proceeds to offer his weak proof: he says that when we assume these ideas, 'we do not really extend our knowledge beyond the objects of possible experience; we extend only the empirical unity of such experience' (A674/B702). For more on this see Guyer (1990, 33).

[15] Friedman had to address the problem of rationality in the development of science for two reasons: first, because he accepted Kuhn's historiographical account of revolutions in science, and second, because, in his model, scientific revolutions are not merely a fact of history but also a necessity (Friedman 2001, 64).

[16] Friedman (2008a, 245–249; cf. 251) says that he is actually in partial disagreement with Cassirer. He disagrees with him as regards the interpretation of Kant's philosophy. Friedman thinks that Cassirer downplays the role of the faculty of pure sensibility in favour of the faculty of pure understanding. He is not satisfied with preserving just mathematical continuity in the history of science as Cassirer is. He wants to know how a new theory is not just mathematically possible but also physically or empirically possible. 'Like the Marbourg school, ... I want to confine the discussion to the conceptual realm and avoid ontology; unlike the Marbourg School, however, I agree with Kuhn that purely mathematical continuity and convergence is not sufficient' (Friedman 2008a, 249n25).

[17] Friedman says that Kuhn can be seen as following Emile Meyerson rather than Cassirer in favouring substantialistic or ontological continuity in the history of science over mathematical continuity that is espoused by Cassirer. 'Kuhn consistently gives an ontological rather than a mathematical interpretation to the question of theoretical convergence over time: The question always is whether our theories can be said to converge to an independently existing "truth" about reality, to a theory-independent external world. It follows then that Kuhn's rejection of intertheoretic convergence cannot be taken as a straightforward confutation of Cassirer's position. For Kuhn simply assumes, in harmony with the Meyersonian viewpoint, that there is rational continuity over time only if there is substantial identity' (Friedman 2008a, 246).

[18] '[My] implementation of this idea of relativized constitutively *a priori* principles (of geometry and mechanics) essentially depends on an historical argument describing the developmental process by which the transition from Newton to Einstein actually took place, as mediated, in my view, by the parallel developments in scientific philosophy...' (Friedman 2008b, 96).

[19] 'Philosophy, throughout its close association with the sciences, *has functioned in precisely this way*' (Friedman 2001, 23; emphasis added).

[20] Van Fraassen (2006), for instance, challenges Friedman's account of continuity between Aristotelian and Newtonian physics.

[21] Cf. Chang (2008, 114): 'In [Philipp] Frank's view, science needs to educate metaphysics, not *vice versa*.'

[22] 'According to Reichenbach (and the logical empiricists more generally), Einstein's new theory is so radically incommensurable with Newtonian theory that the Kantian philosophy itself needs also to be radically revised: A new revolutionary form of scientific philosophy (logical empiricism) is now required in the wake of Einstein's revolutionary theory' (Friedman 2008a, 248).

[23] It is interesting to note that Kuhn saw himself as a Kantian with moveable categories (Kuhn 2000, 264), but also as sharing 'Hume's itch' (Kuhn 1983, 570), i.e., the irresistible and unsatisfiable urge to look for a rational justification of learning from experience. Hume turned to (or settled for) explanation and Kuhn points to a more Wittgensteinian understanding of things. He says that the itch may be intrinsic to the game we play involving induction, and asks for an explanation of what makes this game and the form of life it underpins viable. The explanation he seeks is not, however, empirical, but rather more of the form of a Wittgensteinian description. For criticism of Kuhn on this particular issue see Rorty (1991, 40).

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[24] A transcendental reading of Kuhn's work, which differs, however, from Friedman's, is also proposed in Kindi (2005). This account does not attribute to Kuhn Friedman's aspiration to vindicate transcendentally the rationality of scientific progress, but rather, explains how the use of history may bring forward the diverse conditions in the history of science that have made, and make, science as a practice possible.

[25] According to Habermas (1998, 407), 'philosophy surrenders its claim to be the sole representative in matters of rationality and enters into a nonexclusive division of labor with the reconstructive sciences. It has the aim of clarifying the presuppositions of the rationality of processes of reaching understanding that may be presumed to be universal because they are unavoidable.'

[26] '[S]o long as we are unable to see a perspicuous internal relation between the categorical frameworks of Aristotelian and Newtonian physics, we do not know precisely in what sense Aristotle, in contrast to Newton, wanted to "explain" natural processes. Simply noting the competition between various paradigms comes close to confessing that we do not yet understand the physics and metaphysics of Aristotle as well as we do the basic assumptions about nature in classical mechanics' (Habermas 1998, 417). Habermas admits that the ideal of the universality of meaning 'is a presupposition that, from the perspective of the observer, often—and under the microscope of the ethnomethodologist, even always—turns out to be mistaken' (Habermas 2003, 111).

[27] 'I find it hard to burden pre-dynastic Egyptians, ninth-century French serfs and early-twentieth-century Yanomamö tribesmen with the view that they are acting correctly if their action is based on a norm on which there would be universal consensus in an ideal speech situation. The notion that social institutions should be based on the free consent of those affected is a rather recent Western invention, but one which is now widely held. The notions that an action is morally acceptable or a belief "true" if they would be the object of universal consensus under ideal conditions is an even more recent invention held perhaps by a couple of professional philosophers in Germany and the United States' (Geuss 1981, 66–67). Cf. Sunstein (2006) who argues, *pace* Habermas, that deliberating groups often converge on falsehoods rather than truths and Chang (2008, 115) who says that 'in this post-modern age, we cannot escape the pluralist question: what would be so wrong with having different parts of the human epistemic community pursuing the study of nature on the basis of different sets of constitutive principles?'.

[28] Given that Friedman sees Kant's philosophy as providing foundations for Newtonian theory (Friedman 2008a, 250), one might say that Friedman himself, in reconfiguring the Kantian approach, is attempting a similar thing.

[29] It should be noted that Kuhn himself did not think that we should resort to an abstract ideal of rationality, provided perhaps by philosophy, by which to judge whether scientific development is rational. He claimed that scientific behaviour is, in principle, rational. His view was that 'if history or any other empirical discipline leads us to believe that the development of science depends essentially on behavior that we have previously thought to be irrational, then we should conclude not that science is irrational but that our notion of rationality needs adjustment here and there' (Kuhn 1971, 144).

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