

# Popper and the Achilles' heel of positivism

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## 1. Introduction

Particularly for his contributions to the domain of philosophy of science Popper is highly respected. One of his main concerns was the problem of *demarcation*, which intimately coheres with the problem of *induction*.

## 2. Sense experience and its limitations

Within positivistic circles the issue of demarcation was inspired by the ideal to provide an experiential foundation for reliable scientific knowledge. The term 'empirical' is normally restricted to *sense experience*.

Much has been written about the philosophical orientation of positivism. The essential element which I want to lift out within this context is the emphasis laid by positivism upon *sense experience*. Of course one can relate this to the age-old epistemological quest to understand the *sources* of knowledge. Traditionally there were two main candidates: the *senses* and *reason* (intellect). Sometimes intuition is introduced either as a part of the former or of the latter, while in a few instances philosophers viewed intuition as a faculty transcending the confines both of *sensibility* and *rationality*.

Although human knowledge unfolds in the formulation of arguments, no single argumentation can side-step the *concepts* present in the *statements* or *propositions*. Implicitly or explicitly philosophers of science, in their attempt to give an account of the status of scientific knowledge, therefore have to come to terms with the nature of concept formation.

Cassirer points out that the concept of number first of all helped us to appreciate the nature and value of *concept formation* as such. Surely, Pythagorean thinking overestimated the role of number by claiming that number constitutes the *essence* of every entity. However, by leaving this metaphysical perspective aside we were enabled, according to Cassirer, to realize that although number does not constitute the essence of things, it does form the foundation for *rational knowledge*.<sup>1</sup> Of course this acknowledgement does cause serious problems for an account of concepts based upon (sense) experience. The human senses are always directed towards different kinds of *entities* and *processes*. For example, one can *observe* the different people present at a conference and see how they interact in the course of the event. One can even *count* those who are present at the event and assign a *number* to it, simply because those attending the conference individually and collectively display *quantitative properties*. However, in terms of affirming “sense experience” as the ultimate source of knowledge the crucial question arises: is it possible to come to a *sensory* observation (perception) of the numerical (and other) aspect(s) of the event?

### 3. The ‘objectivity’ of science: ‘reason’ protected from faith?

Within the empiricistic tradition – in modern philosophy advocated by Locke, Berkeley and Hume – “sense data” receives a central position. In the thought of Kant a peculiar relationship between “chaotic sense material” and the ordering function of “thought categories” is portrayed.

It is remarkable to note how influential this orientation of Kant is, for Popper still defends it:

Thus Kant was right that it is our intellect which imposes its laws – its ideas, its rules – upon the inarticulate mass of our ‘sensations’ and thereby brings order into them (1972:68).

The distinctions introduced by Kant in this regard reflect his own attempt to arrive at a *demarkation* between (natural) science and practical faith. His position turned out to be an alternative to the traditional Roman Catholic distinction between *reason* and *faith*, although Kant's motivation for making this distinction stems from a different basic motive. The dualism between nature and grace was replaced by the dialectic between nature and freedom. Kant wanted to provide a firm foundation for the preceding ideal of an encompassing natural science which is restricted to the domain of sense experience (chaotic sensory impressions). Within the supersen-

1 “Der Anspruch, in der Zahl die Substanz der Dinge zu erfassen, tritt freilich allmählich zurück; aber zugleich vertieft und verschärft sich die Einsicht, dass in ihr die Substanz der rationalen Erkenntnis wurzelt” (Cassirer, 1910:35).

sory domain of practical freedom the category of causality does not apply. His famous statement is: “Ich mußte also das Wissen aufheben, um zum Glauben Platz zu bekommen” (1787, Introduction to the second edition, B:xxx).<sup>1</sup>

#### 4. Faith in science

Positivism and neo-positivism pursued this split to its ultimate consequences by claiming that “science“ is an “objective“ and “neutral“ enterprise. With “(sense-) experience“ as the sole and final judge, the criterion of *empirical verification* is introduced to disqualify any and all philosophical presuppositions. “Science“ is supposed to be without any presuppositions whatsoever. Within the ‘circle’ of Vienna *metaphysics* was ridiculed and rejected while ‘science’ was promoted to be the only reliable guide to life.

#### 5. The alternative route proposed by Popper

Hacohen points out that Popper “sought to overcome the gap the circle had opened between science and philosophy” (2002:195). By attempting this Popper once again opened the avenue to historical perspectives, because there is no single discipline (special science) which does not mirror within its own confines the successive trends manifested in the history of philosophy. But we have to explore the historical background a bit further in order to appreciate what Popper did.

##### 5.1 Kant's ultimate trust in ‘reason’

The position taken by (neo-)positivism certainly was not totally new or original. Already Kant was convinced by his British predecessor, David Hume, that *exact natural (physical) laws* cannot be founded in “experience.” After all, Kant could not agree with Hume that we obtain *all* knowledge from sensory perception or “experience” alone.<sup>2</sup> What impressed Kant particularly is the ability of human beings to produce an intellectual formulation of the laws which things in nature obey. As a consequence he focussed his attention on the (epistemological) question *how* such knowledge is *possible*.

Kant was particularly impressed by the contribution of Galileo to the development of the modern natural sciences. What impressed him is that Galileo formulated his law of inertia with the aid of a pure *thought-exper-*

1 Max Müller translates this statement as follows: “I had therefore to remove *knowledge*, in order to make room for belief” (1961:512).

2 Hume claimed: “To hate, to love, to think, to feel, to see, all this is nothing but to perceive” (*A Treatise of Human Nature*, I,2,6).

*iment*. In his famous treatise on “two new sciences” (1638) Galileo used the following thought-experiment: if a body is put in motion on an indefinitely extended track, *then* this body would *continue* its motion infinitely, i.e. it would not discontinue its motion **except** if something exerts power on it (e.g. gravity or friction).<sup>1</sup>

From this Kant draws the following conclusion: if it is possible for Galileo to formulate a thought experiment out of the spontaneous subjectivity of theoretical thought and to deduce a *natural law* from it – the kinematical law of *inertia* – then this *must* entail that elements of knowledge are *previously* (*a priori*) present *within* the human mind, which in the first place makes possible our knowledge of reality.

What is known as Kant’s so-called ‘Copernican’ revolution in epistemology – in ascribing the primacy no longer to the ‘object’ but to the (formal law-giving) **subject** – reinforced the notion of things within nature as ‘objects’. Someone inclined to defend the neutrality of *observation* normally would be willing to accept as the most general *observation-term* the notion of an ‘object’: all the different things in nature are to be seen as ‘objects’. However, this *observation-term* in itself displays the tremendous *subjectivistic* assumption so deeply impregnated in our Western notion of science – as such causing the inability to appraise things in nature as genuine **subjects**, i.e. as being subjected to physical laws for their existence as material things.

In so far as physical entities are *material* they are not *objects* but **subjects** (subject to physical laws), and in so far as they are *objects* they are considered according to some or other *non-physical* facet – for example as something *perceived* (*sense-object*), as something analysed (identified and distinguished from something else – *logical-analytical* object), as something bought or sold (*economic* object), and so on. Therefore, although things such as these could be *objectified* by humans, this objectification pre-supposes their primary existence as (physical) *subjects*. Speaking about them in all possible contexts as *objects* simply underscores the powerful subjectivistic (human-centred) legacy operative in Western thinking!

## **5.2 Setting a new scene: transcending (neo-)positivism**

(Neo-)positivism can be described as the philosophical idolization of the

1 Galileo thus turned the Aristotelian conception upside down, for according the Aristotle something moving is constantly in need of a *cause*. Galileo realized that movement does not need a cause – only a change of movement (for instance *acceleration* or *deceleration*) requires a cause

*experimental method* on the basis of *sensory perception*. Neemann aptly refers to this conviction with an apology to the biblical saying: in the beginning was the Word. “*Am Anfang war die Methode.*” (“In the beginning was the Method” – 1986:70.) The central principle of the *Wiener Kreis*, in the twenties and thirties of the 20th century, was that of “*verification.*”

### 5.2.1 Wittgenstein and Popper

Already Ernst Mach claimed – on the grounds of *empirical* (i.e. sensory) perception – that only mathematics and physics are to be allowed within in the domain of the sciences.

This delimitation of science led Wittgenstein, the mathematician-engineer-philosopher, to the point of view that the *limits* of my language are the *limits* of my world (Tractatus 5.6.). According to Wittgenstein the task of philosophy is to delimit the controversial terrain of the natural sciences (= physics) (4.113) – and the totality of the natural sciences constitutes the totality of *true* propositions (4.11). That which transcends the propositions of physics (which is meaningful) and logic (the propositions of which are tautologies and therefore meaningless: 4.461) *cannot be known or linguistically expressed* – it belongs to the sphere of *nonsense* (*Unsinn*). The objection that the Tractatus itself would be a victim of such a delimitation of science (to logic and natural science) is obviated by Wittgenstein with his comment that his propositions serve an illuminating end:

anyone who understands me eventually recognizes them as nonsensical, when he has used them – as steps – to climb up beyond them. (He must, so to speak, throw away the ladder after he has climbed up it) (6.54)!

Karl Popper reacted strongly against this attempt at delimitation by Wittgenstein. He investigates, for instance, the following sentence by Wittgenstein: “Philosophy is no theory, but an activity” (4.112). This sentence clearly does *not* belong to the totality of natural scientific propositions, and therefore *also* not to the totality of true propositions. On the other hand it is not a *false* proposition either, since if it was, then its negation would have to be true and therefore it would belong to the natural sciences. The only possibility then would be the mentioned conclusion of Wittgenstein (6.54): the sentence is nonsensical. Although Wittgenstein admits with this that the Tractatus is nonsensical, he declares in the final paragraph of the *Preface* that the truth of his notions appear to him *unassailable* and *definitive*. He is even of the opinion that he has on all cardinal points found the *final solution* to the problems!

In a radical fashion Popper responds:

“This shows that we can communicate unassailably and definitely true thoughts by way of propositions which are admittedly nonsensical, and

that we can solve problems *finally* by propounding *nonsense*.” The implication is that “[i]t means that all the metaphysical nonsense against which Bacon, Hume, Kant and Russell have fought for centuries may now comfortably settle down, and even frankly admit that it is nonsense. For we now have a new kind of nonsense at our disposal, nonsense that communicates thoughts whose truth is unassailable and definitive; in other words, *deeply significant nonsense*” (cf. 1966-II:297)!

Popper asks himself how one can oppose this position of Wittgenstein. Every possible objection against it, after all, is philosophical in nature and therefore *nonsense*!

According to Popper this simply constitutes a *fortified dogmatism*:

All that is required, is to delimit the concept sense (or: *meaning*) in an appropriately *narrow* way so as to rid oneself of all awkward questions simply by saying that one does not find them *meaningful*. Every reasoned objection *to* this conception of meaning is simply rejected as *nonsensical*: Once enthroned, the dogma of meaning is for ever raised above the possibility of attack. It is unassailable and definitive (1966-II:297).

This meaning-conception of Wittgenstein, with its included delimitation of science, is just as untenable as the “verification principle” of neo-positivism. The term “logical positivism” (or logical empiricism) was brought into being to refer to a group of philosophers, logicians and mathematicians who became known in Vienna as “*der Wiener Kreis*.” The movement originally centered around Moritz Schlick, with philosophically oriented members such as Carnap, Neurath, Feigl, Waismann, Zilsel and Kraft, as well as natural scientific and mathematically oriented members like Frank, Menger, Gödel and Hahn. Carnap, Neurath and Hahn in 1929 published a manifesto entitled “*Wissenschaftliche Weltauffassung, Der Wiener Kreis*.” In this circle Wittgenstein’s *Tractatus* was also discussed and from it (cf. 4.024) they borrowed their famous verification principle: *the meaning of a statement lies in the manner by which it is verified*.

In his *Language, Truth and Logic* (1936) A.J. Ayer explains that factual assertions are subject to the following criterion of verification: a sentence is meaningful for any specific person if and *only* if that person knows which perceptions would lead him (under certain conditions) to accept the proposition as true or to reject them as false (1967:35). A closer analysis causes Ayer to distinguish between a *strong* and a *weak sense* of verification. A proposition is verifiable in the first sense, if and only if the truth thereof can be conclusively determined in experience. A proposition is verifiable in the latter sense if it is possible to render the experience probable (1967:36-38). Ayer fully realizes that general formulations of laws *cannot* be conclusively verified – in consequence he has to accept verification in the weak sense. In a later preface (1946) he is nonetheless of the

opinion that there exists a class of empirical propositions which are conclusively verifiable. These are the basic propositions which refers exclusively to the content of a *single* experience and which can be identified as unique. Ayer is convinced that he has eliminated all metaphysics by means of this verification-criterion.

The newer theory of science of the past 40 years has realized, due to the influence of Popper, Toulmin, Polanyi (originally a chemist) and especially Thomas Kuhn (physicist) that even *physics* is inevitably gripped by a theoretical picture of reality (paradigm) and that it is possible to speak meaningfully of an ultimate commitment in every scientific activity – a central conviction out of which the scientist accounts for the deepest fundamental questions of doing science. This realization came about partly because of the *non-verifiability* of the (neo-positivist) verification principle.

### 5.2.2 Popper's 'critical rationalism'

As an alternative to (neo-)positivism Popper defends a *critical rationalism*. Popper explains that the choice he had to make does not concern “simply an intellectual affair” because it is “a moral decision” (1966-II: 232). If only that which can be defended by “means of argument or experience” is considered to be acceptable” then we have an uncritical or comprehensive rationalism. This boils down to “the principle that any assumption which cannot be supported either by argument or by experience is to be discarded” (Popper, 1966-II:230). According to Popper this kind of rationalism is demonstrably inconsistent:

Now it is easy to see that this principle of an uncritical rationalism is inconsistent for since it cannot, in its turn, be supported by argument or by experience, it implies that it should itself be discarded. (It is analogous to the paradox of the liar, i.e. to a sentence which asserts its own falsity.)

Uncritical rationalism is therefore logically untenable; and since a purely logical argument can show this, uncritical rationalism can be defeated by its own chosen weapon, argument (Popper, 1966-II:230).

Popper proceeds by generalizing this criticism. He says that since “all argument must proceed from assumptions, it is plainly impossible to demand that all assumptions should be based on argument” (Popper, 1966-II:230). He explicitly rejects the demand raised by many philosophers, namely that we should start without any assumptions whatsoever.

In anticipation of Gadamer's criticism of Enlightenment, manifested in its prejudice against prejudice,<sup>1</sup> Popper shows that the “assumption” behind

1 “The overcoming of all prejudices, this global demand of the Enlightenment, will itself prove to be a prejudice, and removing it opens the way to an appropriate understanding

the rejection of all assumptions should be recognized:

For they themselves rest upon the truly colossal assumption that it is possible to start without, or with only a few assumptions, and still to obtain results that are worth while. (Indeed, this principle of avoiding all presuppositions is not, as some may think, a counsel of perfection, but a form of the paradox of the liar) (Popper, 1966-II:230).

Since neither logical argument nor experience can establish the rationalist attitude, Popper opts for a different stance: that of *critical rationalism*. He first of all points out that

whoever adopts the rationalist attitude does so because he has adopted, consciously or unconsciously, some proposal, or decision, or belief, or behaviour; an adoption which may be called 'irrational'. Whether this adoption is tentative or leads to a settled habit, we may describe it as an irrational faith in *reason*. So rationalism is necessarily far from comprehensive or self-contained. This has frequently been overlooked by rationalists who thus exposed themselves to a beating in their own field and by their own favourite weapon whenever an irrationalist took the trouble to turn it against them. And indeed it did not escape the attention of some enemies of rationalism that one can always refuse to accept arguments, either all arguments or those of a certain kind; and that such an attitude can be carried through without becoming logically inconsistent. This led them to see that the uncritical rationalist who believes that rationalism is self-contained and can be established by argument must be wrong. Irrationalism is logically superior to uncritical rationalism (Popper, 1966-II:231).

This view of Popper indeed resounds not only in the thinking of Gadamer, but also in the works of another prominent philosopher of science, Wolfgang Stegmüller. In reaction to the mentioned attempt of Kant to remove science in order to make room for belief, Stegmüller says:

One does not have to restrict knowledge in order to make room for faith. Much rather one already has to believe in something to be able to speak about knowing and science at all.<sup>1</sup>

This insight should be connected to the nature of *evidence*. Stegmüller argues that one can believe in evidence or that one cannot believe in it, but this belief or unbelief is not capable of acquiring a more basic foundation. It is a primordial decision preceding all rationality. It has to be taken in every single case where something has to be known.<sup>2</sup>

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of the finitude which dominates not only our humanity but also our historical consciousness" (Gadamer, 1998:276).

- 1 "Man muss nicht das Wissen beseitigen, um den Glauben Platz zu machen. Vielmehr muss man bereits etwas glauben, um überhaupt von Wissen und Wissenschaft reden zu können" – Stegmüller, 1969:33.
- 2 "An Einsicht kann man glauben oder nicht glauben, man kann diesen Glauben oder Unglauben aber nicht weiter begründen, ... Es ist eine 'vorrationalen Urentscheidung', die hier getroffen werden muss, und zwar in jeden einzelnen Falle, wo etwas anerkannt

Similarly, in harmony with Popper's acknowledgement that the confidence in the rationality of human thinking in itself is not rational, Stegmüller points out that within no single domain of knowing thinking can lay claim of a self-assurance:

somewhere an ultimate knowing must be given; without that we could not even start<sup>1</sup> ... We should already 'dispose of' an absolute evidence. i.e. we have to believe in it in advance,<sup>2</sup> ... in science *believing* is found, in religion one *knows* (or: pretends to know).<sup>3</sup>

This enlarged approach created room for the conviction that the range of science should not be narrowly reduced to (the methods of) mathematics, physics and logic (as the modern *natural science-ideal* claims) – it indeed encompasses *all* of reality.

## 6. The Achilles' heel of positivism

Popper discusses universality first of all with reference to what he calls *strict* and *numerical* universality (1968:62 ff.). It is clear to Popper that the universality of natural laws precludes any attempt to ascertain empirically every single event to which the law might apply:

For the verification of a natural law could only be carried out by empirically ascertaining every single event to which the law might apply, and by finding that every such event actually conforms to the law – clearly an impossible task (Popper, 1968:63).

The other side of the coin is that Popper does not consider it to be meaningful to establish a direct confrontation between statements and observations. He realizes that human observation is already intertwined with conceptual elements.

The psychologist bias poses the question “how could we ever reach any knowledge of facts if not through sense-perception?” (Popper, 1968:94). Whatever we know about the “world of facts must therefore be expressible in the form of statements *about* our *experiences*” (Popper, 1968:94). Popper then argues that this doctrine “founders” in his “opinion on the problems of induction and of universals” (Popper, 1968:94).

It is noteworthy that Bernays introduces the conviction that the “proper characteristic of rationality” is “to be found in the conceptual element”

werden soll” (Stegmüller, 1969:169).

- 1 “Irgendein absolutes Wissen muß es geben; ohne dieses könnten wir überhaupt nicht beginnen” (1969:194).
- 2 “Absolute Evidenz müssen wir schon ‘haben’, d.h. wir müssen an sie bereits glauben, ...” (1969:194)
- 3 “... in der Wissenschaft wird geglaubt, in der Religion weiss man (oder: behauptet man, zu wissen)” (1969:212).

(1974:601). On this basis he supports Popper in the latter's emphasis on the presence of conceptual elements in observation:

All empirical investigations of nature are based on this fundamental stock of concepts contained in our background knowledge. Popper has repeatedly stressed the circumstance that the statements which we ordinarily regard as simply observational already presuppose this conceptual basis, so that in a proper sense we cannot say that natural science starts from observations (Bernays, 1974: 602).

Unfortunately, in his subsequent discussion of universality, Popper does not distinguish between the universality of *properties* and the universality of *entities*. This distinction is particularly useful when it comes to a criticism of the *conceptual* untenability of positivism.

Let us explore this issue in some more detail. In order to highlight the limitations of the senses in the acquisition of knowledge, we consider the concept of matter in terms of some of its main conceptual transformations.

We have referred to the fact that the Pythagoreans adhered to one statement above all else: *everything is number*. After the discovery of irrational numbers – revealing within the seemingly *form-giving* and *delimiting* function of number something *formless* – Greek mathematics as a whole was transformed into a *spatial mode* (the *geometrization* after the initial *arithmetization*). As a consequence *material* entities were no longer described purely in *arithmetical terms*. The aspect of *space* now provided the necessary terms required to characterize material entities. This spatial angle of approach remained in force until the rise of modern philosophy, since philosophers like Descartes (1596-1650) and Kant (1724-1804) still saw the ‘essence’ of material things in their *extension*.

Particularly through the work done by Galileo and Newton the main tendency of classical physics eventually underwent a shift in perspective by attempting to describe all physical phenomena exclusively in terms of (kinematical) *motion*.<sup>1</sup> Writing about the foundations of physics, David Hilbert<sup>2</sup> refers to the *mechanistic ideal of unity in physics* but immediately adds the remark that we now finally have to free us from this untenable

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1 The British philosopher, Thomas Hobbes (1588-1679), was familiar with the mechanics of Galileo enabling him – as opposed to Descartes – to employ the basic concept *moving body* as descriptive tool.

2 Perhaps the greatest mathematician of the 20th century.

ideal (cf. Hilbert, 1970:258).<sup>1</sup>

Since the introduction of the atom theory of Niels Bohr in 1913, and actually since the discovery of radio-activity in 1896 and the discovery of the energy quantum  $h$ ,<sup>2</sup> modern physics realized that matter is indeed characterized by *physical energy operation* – the physical aspect of reality must therefore be seen as the *qualifying function* of matter, stamping physical entities in their energy-operation.

This brief sketch of the genesis and growth of the concept of *matter* illustrates in which way different (modal/aspectual) *property-terms* served to characterize matter – starting with the perspective of *number* and then proceeding to the aspect of *space*, the *kinematical* aspect and eventually the *physical* aspect of reality.

What is important to realize is that the *description* of matter was decisively dependant upon a particular theoretical view of reality (Kuhn would have used the expression *paradigm* or *disciplinary matrix*) which is entailed in the preference which is assigned to specific property-terms. Is it possible to account for this foundational choice in an *empirical* way? Is it possible to *perceive* the numerical aspect? Can we *weigh* the spatial aspect? Can we determine the *volume* of the kinematical aspect? Can we ‘measure’ the ‘distance’ between the spatial aspect and the physical aspect?

The obvious absurdity of these questions not only illustrates the untenability of the positivistic *faith in facts*, but at once points at a crucial distinction implicitly operative throughout the history of the special sciences, namely the distinction between *aspects* and *entities*. These aspects enable our scholarly reflection to establish a universal coherence between different kinds of entities – just think about the (unspecified) *universal scope* of the fundamental laws of *thermodynamics* (which hold for *all possible* physical entities). In general at this level an *implicit choice* of scientific convictions cause a divergence between special scientists. The question concerning the *relationship* and *coherence* between the different aspects of reality (in terms of which we can describe anything) simply cannot be settled with the aid of the positivistic method of (empirical) *perception*

- 1 It is therefore strange that the contemporary physical scientist from Cambridge, Stephen Hawking, still writes: “The eventual goal of science is to provide a single theory that describes the whole universe” (1987:10).
- 2 In order to account for the *discrete* nature of the omission or absorption of energy, Planck postulated that radiant energy is *quantized*, proportional to the frequency  $\nu$  in the formula  $E = h\nu$  – where  $n$  is an integer,  $\nu$  the frequency, and  $h$  the quantum of action (*Wirkungsquantum*) with the value  $6.624 \cdot 10^{-34}$ .

and *verification*.

Positivism did realize that we can only discover the *structural nature* and the laws holding for physical entities by investigating the lawfulness (law-conformity) they evince. However, precisely the difference between the *universality* of a law and the unique instances empirically tested in experimental settings once again unveils the untenability of a positivistic position. A limited number of experimental instances could never warrant the claim of *universality* contained in law statements.

In its materialistic variant positivism reveals even further inconsistencies. Let us look at the typical claim that matter is all there is: *atoms, molecules, and macro-molecules in interaction*. This *statement* claims that there is nothing beyond matter – but what about the statement making this claim!? Is it *true*? If so, then there is something immaterial (**truth**). And what about the natural laws *holding* for material things? They condition *being material* but are not themselves material! Thus both with respect to the *truth-value* and the *universal validity* of natural laws the basic claim of positivistic materialism is self-defeating!

Popper did not make this distinction between modal and typical laws. Making this distinction entails the acknowledgement that differently structured entities all function within universal modal aspects of reality (either as *subjects* or as *objects*). Therefore, whereas *modal laws* are given for all kinds of subjects, *typical entitary laws* are only given for a limited class of subjects. Typical laws always *specify* (but never: *individualize*) the universal modal laws – for example, thermodynamics, as a purely modal physical theory, abstracts from the typical differences between the solid state, the fluid state, and the gaseous state. Discussing the nature of an a priori synthetic element in the “empirical sciences,” Stegmüller raised the following possibility (1969a: 316):

Surely, this cannot imply that the totality of law-statements present in a natural science could be of an a priori nature. Much rather, such an apriorism should limit itself to the construction of a limited number of a priori valid law relationships, while, furthermore, all more specific laws of nature should be dependent on empirical testing.

In fact this distinction is already present in the thought of Kant, who distinguished between his (supposedly universally valid *a priori*) *thought categories* on the one hand and so-called *empirical laws of nature* on the other hand:

We rather have to distinguish empirical laws of nature, which always presuppose particular perceptions, from the pure or general natural laws, which, without having a foundation in particular perceptions, only contain the conditions of their necessary connection in an experience. In respect

of the latter nature and possible experience are entirely the same; and since within these the law-conformity of the necessary connection of appearances in an experience (without which we are totally incapable of knowing any object of the world of the sense), actually is based upon the original laws of the understanding, so it initially does sound strange, but it is nonetheless certain, when I state with respect to the latter: understanding creates its laws (a priori) not out of nature, but prescribes them to nature (1783 par.36:320).<sup>1</sup>

Keeping in mind that we must distinguish laws in an *ontical* sense from our *hypothetical law statements* in scientific formulations, it is still remarkable to note the similarity between the aforementioned statement of Stegmüller and the following explanation of Stafleu (related to the distinction between modal laws and typical laws):

Whereas typical laws can usually be found by induction and generalization of empirical facts or lower level law statements, modal laws are found by abstraction. Euclidean geometry, Galileo's discovery of the laws of motion . . . , and thermodynamic laws are all examples of laws found by abstraction. This state of affairs is reflected in the use of the term "rational mechanics", in distinction from experimental physics (Stafleu, 1980:11).

Whereas Kant ought to receive credit for having wrestled with the dimension of *modal universality* – in his search for the *synthetic a priori* (cf. Strauss, 2000) – positivism and neo-positivism ought to be acknowledged for their emphasis on *experimental testing* (not the same as: *verification!*). Only through studying the *orderliness* or *law-conformity* of entities is it possible to arrive at an understanding of the *type laws* holding for that limited class of entities conforming to their peculiar type laws. In the case of physics it requires empirical research through experimentation. Of course this does not free physics from an overarching and underlying paradigm (theoretical perspective) in which modal properties are also accounted for. Sometimes this dimension of theory formation is implicitly acknowledged when reference is made to *theoretical terms* which cannot directly be tested against actual experiences.

## 7. Concluding remark

Popper accepted a plea of being guilty to the accusation that he "killed" positivism (1974-I:69 ff.). His considerations with regard to universality and the problem of induction could have been strengthened if he would have been able to consider the implications of what we have called *modall/aspectual universality*.

The way in which Stegmüller transformed Kuhn's thought on the basis of Sneed's theory of mathematical physics comes much closer to an actual

<sup>1</sup> This constitutes the motive of logical creation.

acknowledgement of modal universality. According to him, what would appear to be unique and unprecedented in Kuhn's work,

is the fact that he appears to impute irrational behavior to the practitioners of the exact natural sciences (of all people!). And indeed he appears to impute it to both of the forms of the scientific practice distinguished by him. Anyone engaged in normal science is a narrow-minded dogmatist clinging uncritically to his theory. Those engaged in extraordinary research leading to scientific revolutions are religious fanatics under the spell of conversion, trying by all means of persuasion and propaganda to convert others to the *new paradigm* as revealed to themselves (1976, p.vii).

Not only do the natural scientists work in an irrational manner – according to the critics of Kuhn it would appear as if he is also a proponent of the non-inductive nature of the natural sciences.

A comparison between four prominent figures provides the following picture:

- (1) Hume: the natural sciences proceed *inductively* and *non-rationally*;
- (2) Carnap: the natural sciences proceed *inductively* and *rationally*;
- (3) Popper: the natural sciences proceed *non-inductively* and *rationally*;
- (4) Kuhn: the natural sciences proceed *non-inductively* and *non-rationally*; (cf. Stegmüller, 1975:487-490).

It will take us too far to explore in more detail the way in which Stegmüller accounts for a threefold *immunity* of theories against possible falsifications. It will be sufficient to say that the so-called *structural nucleus* of a theory, which remains untouched when hypothetical extensions of it are challenged with falsification, operates on the level of *modal universality*. Only those scientists who succeed in erecting new structural nuclei are involved in *extraordinary* research. Normal scientists merely explore the structural nucleus of a theory by working on hypothetical extensions of it.

It turns out that Popper is mainly focused on *abnormal science*, whereas Stegmüller is of the opinion that the processes of rigorous testing and confirmation or falsification actually typically belong to *normal science*. If the normal scientist is subjected to the norm to be constantly involved in the change of the structural nucleus of theories, it would entail an inhuman challenge to the average scientist: "Become a Newton or an Einstein!" He remarks:

In so far as this maxim is directed towards 'normal scientists', who are in their domain of work constantly involved in sober and productive labour and who are also by far the majority of scientists, it is gruesome and inhuman. It implies that the assessment of every scholarly competence is made dependent upon the extent to which it conforms to this demand and that

with it a devastating value-judgment is passed upon practically all scientists (Stegmüller, 1980/1:52).

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