TOLERANCE IN SCIENCE FROM A PHILOSOPHICAL PERSPECTIVE. AN ESSAY ON ITS FORMS AND ITS NECESSITY IN MODERN TIMES

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This paper is about the meaning of tolerance in science from a philosophical perspective (e.g. that of Carnap, Quine, and Davidson) as related to virtues and the context of changing languages and paradigms of science. The notion of "science" is used in the English sense of the term; that is as denoting the natural sciences and mathematics, but not the humanities and the social sciences. The common roots of tolerance in the Modern philosophy of science is found in the Enlightenment, particularly the work of Voltaire, whom both Quine and Popper refer to as an authority on the issue.

1. Introduction: Tolerance and Science – an Impossible Relationship?

This paper[1] is more of an essayistic synopsis of some systematic thoughts and historical observations rather than an elaborated and coherent analysis of a topic which has long been neglected in the philosophy of science as well as in general philosophy. It will start with some preliminary remarks about tolerance and science in order to narrow down the issues that will be discussed. The second part brings in a historical perspective on the subject in order to show why the topic is relevant for the philosophy of science in modern times. The following two sections will deal with some systematic aspects of tolerance in science in the modern discussion. Here, the focus will be on analytical philosophy (Carnap, Quine and Davidson) on the one hand, and critical rationalism (Popper and Albert) on the other. The main part of the paper will be devoted to the meaning of tolerance and related virtues in the context of changing languages of science and changing paradigms of science. Throughout the paper, 'science' will be used in the English meaning, though a broadly interpreted one: The term is meant to denote the natural sciences and mathematics, but *not* the humanities and the social sciences.

1 This paper is a slightly modified and extended version of my talk delivered at the conference 'Toleration and Tolerance' of the History of Ideas Research Centre in Krakow, October 18th–20th, 2012. English translations of German sources in the text are mine. Many thanks to Janelle Pötzsch, who polished the English of this printed version of the talk.

At first glance, the terms 'tolerance' and 'science' seem to address quite heterogeneous or even alien areas of human conduct and human action. Tolerance stems from the religious and political sphere and developed into a key concept of *moral* (or practical) philosophy during the Enlightenment. Science, on the other hand, is a topic of *theoretical* philosophy – of logic, epistemology, and methodology. Moreover, tolerance seems to be located in a field of *subjective* virtues and attitudes like respect, understanding, forbearance and, at least sometimes, a feeling of superiority. It is a virtue whose limits of relevance and application are quite difficult to define. Science, however, seems to represent *objectivity* at its best – truth, exactitude, demonstration and empirical verification, fixed methodological rules and rational foundation. Its limits seem to be clear-cut. Finally, tolerance seems to be inseparably connected to personal opinions and ideological word-views: Within certain limits, opinions and world-views are sustained by a tolerant person, though they are not accepted or even adapted. Science, on the other hand, seems to have no place for such opinions or world-views. Its laws, theories and propositions are either right or wrong. Scientists do not have to suffer ambiguous and uncontrollable statements of other people. So much about the 'everyday speech' about 'tolerance' and 'science' and its superficialities.

A closer look, which takes into account a more precise definition of tolerance, can reveal its potential function for science: Tolerance is an attitude of a person or a social group towards convictions, beliefs, actions or habits of other persons or groups, which are understood as relevant for some reason, which are also understood as false (or at least as deviating from accepted norms) for some reason, and which are condoned ('geduldet'), even though the first person or group may be in a position to suppress or punish the opposite party. While *tolerance*, properly justified, should be understood as an ethical or epistemic virtue, *toleration* is its respective and verifiable expression or behaviour.

Now, keeping this definition in mind, what does it mean to argue for tolerance in science? Several qualifications are necessary in order to specify this question:

First, I would like to stress that I discuss tolerance *in* science, not tolerance *with* science. I do not discuss, for example, the intolerance of the church with respect to Copernicus or Galileo. I concern myself with, e.g., tolerant or intolerant behaviour among Newtonians and Leibnizians or Cartesians in 18th century physics, or among formalists and intuitivists or constructivists in 20th century mathematics. *Secondly*, I won't deal with tolerance in the context of everyday-controversies among scientists. This means that I won't discuss issues about outward reputation, resources and institutional influence or power. Tolerance in such disputes is *not peculiar* for science, and therefore out of the scope of this talk. *Thirdly*, I will take science as an *ideal* enterprise, which is governed, or should be governed, by certain common values as formulated in particular by Robert Merton; Universalism, disinterestedness, organized skepticism and communism (i.e. the common property

of scientific knowledge) should rule science and scientific conduct. The question is whether and why we might need tolerance *in addition* to these widely accepted values, as an epistemic or ethical virtue of science. If the ideal scientific discourse is coined by a common search for truth, and ruled by organised skepticism, do we still need tolerance as a surplus? The counter question is whether tolerance in science does not undermine the rational standards of science. If we have good reasons to *refuse* the scientific claims of an opposing person or group, doesn't scientific rationality require us *not* to tolerate such claims, but to try to eliminate it from the scientific discourse? And *if* the answer to this question should be 'no' or, in other words, *if* tolerance is a *necessary* element at least of some scientific discourses, further questions emerge: What are the features of these discourses that make tolerance indispensable? What are the *limits of tolerance* which have to be drawn in order not to hinder or even to end the progress of science? I will address only some of these questions in the second half of my paper. Beforehand, it may be informative and helpful to insert a short digression on 'tolerance in science' from the perspective of the history of ideas.

2. 'History of Ideas in a Nutshell': Tolerance in Classical and Modern Science

For our purposes, it's advisable to begin with a distinction between 'classical' and 'modern science'. The first ideal dominated science and its philosophy from Antiquity to the 19th century; the second one developed in the late 19th century and is generally accepted today.[2] To put this distinction very shortly: The general classical premise was that science gains invariable, true and indisputable knowledge of nature and man himself. In other words: The idea of science from Aristotle to the late 19th century was shaped by the conviction that scientific knowledge is *epistémé* in the traditional sense. One important aspect, perhaps even the most dominating aspect, of most traditional attempts to demarcate science was to draw a line between *epistémé* in this strong sense and weaker forms of knowledge, which are not certain and may even be fallacious and deceiving. *Scientia*, *science, Wissenschaft* in its classical meaning is meant to establish one (and *only* one) logical system of propositions for each area of experience. Classical science is *unitary* in the sense that it does not allow for different theories within *different* conceptual frameworks that describe and explain the *same* field of experience. If two or more such theories occur, the classical ideal of science demands that *all but one* are false and can be demonstrated to be false. This 'unitarianism' with respect to scientific

2 For a detailed systematic differentiation and historical analysis of classical and modern science *cf.* H. Pulte: *Axiomatik und Empirie. Eine wissenschaftstheoriegeschichtliche Untersuchung zur mathematischen Naturphilosophie von Newton bis Neumann.* Darmstadt: Wissenschaftliche Buchgesellschaft 2005, Ch. I.

truth was an essential aspect of most influential philosophies of science from the 17th century onwards: Both classical *empiricism* from Bacon to Mill as well as classical *rationalism* from Descartes to Wolff are unitarian in this sense. Kant's transcendental foundation of science picked up this feature and carried it over to the heydays of Neokantianism and even to the Erlangen school of Constructivism. In classical science and its philosophy, we hardly encounter serious and interesting discussions about tolerance: From the point of view of the history of the idea of *tolerance*, science is a downright *latecomer* in comparison to religious and political thinking. 'Tolerance' in religion and politics was an important achievement of modern times that was brought about both by early modern processes of secularization and the insights of the Enlightenment that abandoned the idea of absolute truth of *one* religion or *one* political system. At the same time, the Enlightenment declared science to be the field where privileged knowledge with absolute truth can be found. This special epistemic status of science precluded debates about tolerance in science or philosophy of science; as far as I can see, they simply did not exist. To give just one example: Schlüter's extensive study of tolerance in the French Enlightenment entails a detailed and differentiated index on 'tolerance', 'intolerance' and related terms. Among the nearly 100 lemmas, *no single one* deals with science.[3]

The lock-out of tolerance from scientific debates does not mean, of course, that no controversies or battles about scientific issues took place – quite the contrary. The decisive point, however, is that these debates were carried out between parties which each were convinced that they're in the possession of the one *true* system of science, whereas the opposing party is not.

I would like to illustrate this by a controversy that is perhaps the best example of what Thomas S. Kuhn later described as a true conflict between different scientific paradigms, where the members of the struggling scientific communities are committed to different conceptual frameworks and live, ontologically speaking, in different worlds. I am alluding to the famous controversy between Leibniz and Newton, where Samuel Clarke played the role of Newton's governor or, perhaps better, Newton's ventriloquist. This dispute was about opposing understandings of the fundamental concepts of natural philosophy, like space, time, body, matter and force. Leibniz and Clarke exchanged a couple of letters about these subjects, without ever convincing each other. Gradually, the tone of these letters got harsher and harsher. Leibniz starts his last letter by expressing his intention to find out whether his opponent is only interested in struggles without gaining knowledge, or in 'foundations of reason' and 'veraciousness'. Eventually, he claimed victory for his own position with these words: "[…] I believe that any reasonable and unprejudiced man will admit that someone [like me], who forced his opponent to

3 *Cf.* G. Schlüter: *Die französische Toleranzdebatte im Zeitalter der Aufklärung. Materiale und formale Aspekte.* Tübingen: Niemeyer 1992.

neglect this principle [of sufficient reason] has proven his position to be absurd [ihn *ad absurdum* geführt hat]".[4] Newton, on the other hand, accused Leibniz of conceptual fraud, dishonesty and moral inferiority. From an outward point of view, the correspondence ended only because Leibniz died. But actually, the rational discourse has already ended well *before* that, because arguments about the true natural philosophy had turned into moral accusations of the opposing party. No one engaged in this struggle was—*due to classical unitarianism*—able to consider whether the opposing parties *might* be right, or what the consequences of such an assumption might be. The whole epistemological and methodological framework of classical science excluded the *very possibility of forbearing* with the opposite doctrine. In general: Being convinced of the absolute truth of one's own system is a *death sentence* for tolerance and toleration, when incompatible scientific systems are involved. This is the important lesson the controversy between Newton and Leibniz provides with respect to tolerance. And it also holds for comparable foundational controversies within classical science *in general*.

However, this traditional image of science as an epistemologically *privileged* endeavour (in the sense of *unitarianism*) was given up by the end of the 19th century: Science itself underwent revolutionary changes, which were interpreted by most philosophers and historians of science as epistemological *disruptions.* They were brought about by internal developments rather than by external, social, political or philosophical influences. Most influential in this respect was the discovery of non-Euclidean geometries. Virtually as important was another development in mathematical physics: The rise of alternative and empirically equivalent axiomatic systems within rational mechanics and other areas. Both developments paved the way for the conventionalism of Henri Poincaré and Pierre Duhem as a genuinely *new* philosophy of science. They were *also* grist to the mill of a modernised empiricism, as Ernst Mach's phenomenalism and William James's pragmatism. A common denominator of all these strands of empirical philosophy is that they did not adhere to classical unitarianism. Instead, they accepted a *plurality* of equivalent scientific theories that govern the same area of experience. Consequently, James drew this analogy between politics and science in his book *The Pluralistic Universe*: "The pluralistic world is […] more like a federal republic than like an empire or a kingdom."[5]

The new pluralism *dethroned* the old idea of absolute scientific truth of a scientific theory. This means that in James's 'federal republic' of science, the concept of *truth* was either 'abandoned' as an epistemic distinction of first axioms of science and mathematics (as in conventionalism), or it was deflated to weaker forms like the 'economy' of descriptions of phenomena or 'success' of theories as instrumental

4 S. Clarke: *Der Briefwechsel mit G. W. Leibniz von 1715/1716*, ed. by E. Dellian, Hamburg: Meiner 1990, p. 105; cf. also p. 64.

5 W. James: A Pluralistic Universe (1909). In: *Writings 1902–1910*, ed. by B. Kuklick, New York: The Library of America 1987, pp. 625–819, p. 776.

devices (as in phenomenalism and pragmatism). My thesis is that this 'democratisation' of scientific truth made it possible for 'tolerance' to enter the agenda of philosophy of science. Moreover, one might argue that the concept of tolerance became a *necessary* concept in philosophy of science because of this process of 'democratisation' (*cf.* part 3 and 4).

However, the beginnings of explicit philosophical reflections on 'tolerance in science' are difficult to discern. In Poincaré, we find some hints that it makes good sense to be cautious and hesitant when different conventions or sets of conventions have to be chosen from. Different options have different advantages and disadvantages, and it can be damaging for science to disqualify and discard some options too early. We find similar views in Mach's philosophy of science, especially with regard to basic principles and methods of science. James, however, is most explicit in this respect. He underlines the pragmatist view that science always serves different interests, and different interests imply different perspectives on reality, which—in itself—never can be grasped as a *unique* one. Consequently, he considers uniqueness of truth (or unitarianism, as I called it) as a mere illusion: Scientific beliefs are in this sense on equal footings with other beliefs. It is worth quoting him in some length in order to make explicit the emerging relation of 'tolerance in science' to the new understanding of 'scientific truth'. The quotation points at the need to decide *willingly* for and against certain beliefs in concrete situations, and that we are ill-advised when we postpone necessary decisions and simply wait until some super-human, believe-independent truth reveals itself: [6]

> Were we scholastic absolutists, there might be more excuse. If we had an infallible intellect with its objective certitudes, we might feel ourselves disloyal to such a perfect knowledge organ of knowledge in not trusting to it exclusively, in not waiting 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. Indeed we *may* wait if we will—I hope you do not think that I am denying that—but if we do so, we do so at our peril as much as if we believed. In either case we *act*, taking our life in our hands.
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> No one of us should issue vetoes to the other, nor should we bandy words of abuse. We ought, on the contrary, delicately and profoundly to respect one another's mental freedom – then only shall we bring about the intellectual republic; then only shall we have the spirit of inner tolerance without which all outer tolerance is soulless, and which is empiricism's glory; then only shall we live and let live, in speculative as well as in practical things.

6 Id.: The Will to Believe (1896). In: *Writings 1878–1899*, ed. by G. E. Myers, New York: The Library of America 1992, pp. 457–479, p. 478.

The end of this quotation makes it quite clear that James's plea for tolerance is a *universal* one, including both practical decisions in ethics or religious beliefs as well as *speculative* or theoretical decisions in science or philosophy. So at the turn of the century, 'tolerance' was articulated as a virtue also of science, at the latest by William James. This virtue is both an ethical and an epistemic one: James's justifications of tolerance are based on the insight that our interests both trigger our scientific research of reality and are *part* of this reality. This means that *interests* are relevant for us both as knowledge-acquiring beings and as acting beings. As we have no privileged access to absolute truth of certain beliefs, and as certain beliefs correspond to certain interests, we are well-advised to tolerate other beliefs and interests. We gain *more* knowledge and act *better* when we do. Tolerance thus becomes a matter of *scientific prudence*. This implies, however, that scientific prudence can no longer distinguish between belief and knowledge in science. I will come back to this problematic point of James's argument later.

3. From 'Pseudo-Tolerance' to Tolerance: Analytical Philosophy of Science

The third part of my talk focuses on what I call '*pseudo*-tolerance' and 'tolerance' in twentieth-century analytical philosophy. As regards this issue, I think that Carnap, Quine and Davidson are the most interesting thinkers to consider. Tolerance here becomes a topic for exactly the same reason mentioned before: While the logical empiricists followed a program of 'unified science' [*Einheitswissenschaft*], they were confronted by Poincaré's conventionalism and Mach's phenomenalism with counter-arguments to this project. These arguments became all the more serious for members of the Vienna Circle as they modeled their scientific philosophy in the tradition of Mach and Poincaré. And even the development of mathematics from Hilbert onwards—Hilbert being another 'saint' of logical empiricism—pointed towards a *plurality* of scientific languages and systems. Carnap, in his main work *Der logische Aufbau der Welt* (1928) more or less ignored these problems. Later however, in his second main work *Die logische Syntax der Sprache* (1934) he paid attention to the *challenge of plurality* both in the empirical sciences as well as in mathematics. Moreover, his attempt to build up a general *logical syntax* underlying all languages of the sciences and mathematics also faces the problem that *logic itself* is capable of expressing different structures and different types of syntax. Carnap's bold attempt was, so to speak, to *extend conventionalism to logic itself*. For this purpose, he formulated a so-called 'principle of tolerance':[7]

7 R. Carnap: *Die logische Syntax der Sprache. Zweite, unveränderte Auflage*. Wien / New York: Springer 1968, pp. 44–45; *cf.* A. Richardson: The Limits of Tolerance: Carnap's Logico-Philosophical Project in Logical Syntax of Language. In: *The Aristotelian Society*, supplement. vol. LXVIII (1994), pp. 67–82, p. 68.

> Our attitude in general […] be formulated by the *principle of tolerance [Toleranzprinzip]:* We do not want to set up prohibitions [Verbote], but establish conventions [Festsetzungen]. […] *In logic, there is no moral.* Everyone is at liberty to build up his own logic, i.e. his own form of language as he wishes. All that is required of him is that, if he wishes to discuss with us, he must state clearly how he is going to proceed, [he must] give syntactical rules instead of philosophical arguments.

This principle of tolerance, he states earlier in his book, is his 'silver bullet' to overcome the restrictions of classical logic:[8]

> The first attempts to cast the ship of logic off from the firm coast of classical forms were certainly bold, considered from the historical point of view. But they were hampered by the striving after 'correctness'. Now, however, that impediment is overcome, and before us lays the boundless ocean of unlimited possibilities.

This Bacon-like rhetoric of new beginning and break-up can be understood only if we consider the vast range of the principle of tolerance in Carnap's philosophy. It has an internal and an external dimension: Internally, with respect to the program of logical empiricism, he claims that his principle is adequate to settle the foundational disputes within mathematics and the empirical sciences. Tolerance with respect to the choice of the respective mathematical language of science doesn't harm scientific rationality, as these languages can always be translated into each other. For Carnap, there is no need to give up the distinction between scientific knowledge and mere belief, as James did. However, this internal objective target of tolerance cannot be reached within Carnap's framework: His idea of syntax very much depends on the concept of 'analyticity', and different languages in his framework imply different fixations of this concept. This, however, was a core element of the foundational disputes of the time, for example between logicists and intuitionists in the foundational dispute of mathematics.[9] That Carnap tries to shift the philosophical disputes to 'syntax' and thereby to analyticity that obviously has to do the philosophical work for him is not without irony. So-called philosophical pseudo-problems, kicked off at the front door of logical empiricism, reenter the stage from the backdoor, named 'principle of tolerance'.

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8 Carnap: *Die logische Syntax der Sprache*, p. VI.

9 "Logic and mathematics are meant to be shown always to be found in the analytic sentences of the formal systems. That is, the syntactic notion of analyticity seems to be doing genuine philosophical work for Carnap. This would not merely be disagreeable for any naturalist, with whom Carnap happily did not have to deal in *Syntax*, but also for the intuitionists who were among the disputants at that time. Thus, the rhetorical assimilation of foundational issues to pseudoproblems of metaphysics may seem disingenuous." (Richardson: "The Limits of Tolerance", p. 69).

The 'external' dimension of this principle, however, is even much more far-reaching and fundamental: As Carnap makes clear later, this principle serves as a cornerstone of his general philosophical outlook, which he characterises as the "neutral attitude toward the various philosophical forms of language, based on the principle that everyone is free to use the language most suited to his purpose, which I held up throughout my life".[10] Carnap's main idea here is that the principle of tolerance allows for a certain *ontological neutrality* with respect to questions which are 'external' to the chosen language itself: Is there an outward metaphysical reality? What does the structure of the language tell us about this reality?, and so forth. Carnap holds the view that the choice of a certain language does not imply any ontological commitments. To be more precise: We can introduce variables into our language without claiming that they refer to certain outside entities. Again, further analysis of Carnap's syntax by Quine and others has shown that this kind of neutrality cannot work. Carnap himself in later investigations limited his principle of tolerance by pragmatic demands like simplicity, feasibility and usefulness.[11] However, and contrary to James, he did not interpret practical success in realistic terms.

To conclude with Carnap, I would like to stress one more general aspect of the external dimension of his principle of tolerance: It entails an implicit agenda according to which all philosophical problems are problems of syntax. Though his principle may look quite reasonable to all philosophers working within the tradition of logical empiricism, it is hardly acceptable for many or even most philosophers working outside this tradition and interested in preserving some of these traditions: Carnap's attempt to commit philosophy in general to a language that fits his demands of syntax means, by and large, to commit philosophy—at least philosophy of science—to a general 'mathematical language'. I refute the claim that all philosophical problems and interests with respect to science can be formulated in such a language. Therefore, I do not regard Carnap's principle as one that is about 'tolerance'. It is rather a principle of 'pseudo-tolerance' that masks a traditional dogmatism of a certain kind.

Here, I cannot follow up the fate of Carnap's principle in the further development of analytical philosophy. At least I should note that it had certain successors within the analytical tradition. With Carnap's principle and Quine's later critique of the *Two Dogmas of Empiricism* the question of *radical translation* entered the agenda: All our theories are underdetermined by sense experience. Therefore, if two representatives of different theories—formulated in different languages—would like to communicate, the meaning of the words used respectively is not clearly determined by empirical reference. In order to reach a unique determination

10 Carnap: *Mein Weg in die Philosophie (Intellectual Autobiography*, 1963). Stuttgart: Reclam 1999, p. 30.

11 *Cf.* L. Krauth: *Die Philosophie Carnaps.* Wien / New York: Springer 1970, p. 205.

of meaning, each representative has to perform *interpretative efforts* in order to understand his conversational partner. In this context, Quine introduces a "principle of charity" [*Barmherzigkeitsprinzip*] according to which all translations from the alien theory language preserve logical rules, like avoidance of contradictions.[12] In short, Quine's principle of charity introduces a necessary precondition of scientific discourse as a normative claim: We should not presume that our opponents adhere to absurd or irrational beliefs. We should rather—at least until further evidence is available—assume that they pursue their scientific interests as rationally as we do. This kind of tolerance—ironically labeled as 'charity'—seems indispensable for Quine in order to solve the problem of radical translation, i.e. to make possible communication across the borders of different scientific theories.

Later, Donald Davidson accused Quine of perpetuating a *third* dogma of empiricism, i.e. to keep up the old dichotomy of empirical content and conceptual scheme. He wanted to overcome this third dogma, especially in order to master the challenge that Kuhn's incommensurability-thesis posed for analytical philosophy. Davidson described his own approach explicitly as an *interpretative* one, and insofar comparisons to the *hermeneutic* tradition suggest themselves and have actually been drawn.[13] Davidson's main point is that knowledge and interpretation are rooted in *social interaction* between humans and *their interaction* with the world outside. We interpret each other by *assuming* that our conversational partner is also intending to articulate true judgements about the commonly shared world. And we maximise the understanding of our conversational partner by starting with the assumption that his judgements are consistent, that they are intended to be true, and that most of them are indeed true (in the sense of a correspondence theory of truth). Davidson denominates these preconditions of understanding, including scientific understanding, as *charity*.[14] They are principles of *benevolent* interpretation of someone who uses a different (scientific) language. As such, they *do not* yet guarantee scientific understanding: They are no warrantors of understanding, but somehow transcendental *preconditions* of understanding in science. The road from Carnap over Quine to Davidson seems an interesting one to me: It is a road that leads from 'pseudo-tolerance' to real 'tolerance' within analytical philosophy. And though Davidson's position certainly entails profound differences to, say, Dilthey's and Gadamer's, one can say that it initiated a certain convergence of the analytical and hermeneutic tradition.

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12 *Cf.* W. v. O. Quine: *Word and Object.* Cambridge (Mass.): MIT Press 1960, pp. 59 and 69.

13 *Cf.*, above all, the splendid analysis by M. Anacker: *Interpretationale Erkenntnistheorie. Eine kritische Untersuchung im Ausgang von Quine und Davidson.* Paderborn: Mentis 2005, pp. 204–213.

14 *Cf.* D. Davidson: *Wahrheit und Interpretation* (*Inquiries into Truth and Interpretation*, 1984). Frankfurt am Main: Suhrkamp 1990, pp. 183–203 and 204–223; *cf.* also N. Goldberg: Principle of Charity. In: *Dialogue* 43, 4 (2004), pp. 671–683.

4. Tolerance and Verisimilitude: Ethics and Epistemology in Critical Rationalism

The last part of my paper will highlight a position in philosophy of science that is also critical with respect to the hermeneutic tradition, but which reveals some convergent tendencies to it as well. It is about Karl R. Popper's and Hans Albert's critical rationalism. It was mainly this tradition that forced analytical philosophers like Quine and Davidson to dismiss the idea that science can yield certain knowledge: No other strand of modern philosophy of science took leave of the classical ideal of absolute true scientific knowledge as consequently as this one. To quote Popper's famous dictum: "Our science is *not* knowledge (*epistémê*): it can never claim to have attained truth, nor probability."[15]

One lesson Popper drew from this epistemological insight into the revolutions of modern physics is the following: "I may be wrong and you may be right, and by an effort, we may get nearer to the truth."[16] This directive is obviously an implication of the 'loss of certainty' in modern science, already addressed by James and others: *If* we have no criterion at hand that even our 'best' scientific theories are true and *if* there are rival theories which are not proven to be false it is quite reasonable to take these theories seriously. This means to *tolerate* them in a very special sense: They are possible bearers of truth, or they may at least enable us to come closer to truth. As alternative candidates to a given theory, they deserve to be critically examined and checked with respect to their empirical content. Tolerance with respect to alternative theories or hypotheses is a necessary precondition if the scientific enterprise aims at truth or *verisimilitude*, i.e. truthlikeness or *nearness* to truth.[17]

However, tolerance in science in *this sense* has not only an epistemic dimension, but also an *ethical* one: Popper asks for a new 'professional ethics' of science that takes human fallibility seriously. It is an ethic directed *against* epistemic authority *in* science, *against* dogmatic closure of science from criticism and self-criticism, and *for* the elimination of individual failure as a social enterprise and *for* scientific criticism that is disinterested in personal respects, but as clear and specific as possible with respect to matters of fact.[18] This is Popper's idea of intellectual honesty and responsibility in science. It implies scientific tolerance as *both* an epistemic

15 K. R. Popper: *The Logic of Scientific Discovery* (*Logik der Forschung*, 1934). London: Hutchinson 1980, p. 278; the quotation is slightly adapted to the German original.

16 *Id*.: *The Myth of the Framework. In Defence of Science and Rationality*, ed. by M. A. Notturno, London / New York: Routledge 1994, p. xii.

17 *Cf. id*.: Duldsamkeit und intellektuelle Verantwortlichkeit (1981). In: *Auf der Suche nach einer besseren Welt.* München / Zürich: Piper 1999, pp. 213–230, pp. 217–218.

18 *Cf. id*.: Der unbekannte Xenophanes. Ein Versuch, seine Größe nachzuweisen [without date]. In: *Die Welt des Parmenides. Der Ursprung des europäischen Denkens,* ed. by A. F. Petersen, München / Zürich: Piper 2005, esp. pp. 104 and 114–118.

and an ethical virtue. Hans Albert, in his *Traktat über kritische Vernunft*, states likewise that we need such virtues as "bridging principles" [*Brückenprinzipien*] that bypass the distance between ethics and science and demand criticism of science from a *normative* point of view.[19] These bridging principles allow for an understanding of epistemic progress that brings about new moral responsibilities, and for an understanding of moral responsibility that takes into account the available epistemic means.

5. Conclusion

I closed my short synopsis with critical rationalism because this tradition has several advantages over other approaches when we want to take tolerance in science seriously: First, it does *not* combine modern epistemic fallibilism with an inexpensive epistemic relativism (as Paul Feyerabend did, for example), but adheres to the ideal that science is a truth-seeking and progressive enterprise. Mere relativism does not claim *tolerance* for alien scientific attitudes, but allows for *arbitrariness* with respect to such attitudes. This is a fundamental difference. Popper's approach is preferable if we want to justify tolerance in science as an indispensible epistemic and ethical virtue *without* giving up the idea that science is a rational and progressive enterprise. *Secondly*, I think that an important advantage of Popper's understanding of tolerance in science in comparison to the analytical discussion is that he does not develop tolerance from what he calls 'the myth of the framework' (i.e. the conviction of later analytical philosophy that we are captured in a conceptual framework which is defined by our own language of science and which allows only for a discussion of philosophical problems that can be formulated *within* this syntactically well-defined framework) but acknowledges that there are genuine philosophical problems that can be addressed in different frameworks. To put it shortly: In the analytical tradition, tolerance is more of a 'necessary evil' of the linguistic framework, in critical rationalism it is a positive virtue in its own right. *Thirdly*, I think that Popper's approach is also preferable in comparison to that of James, because James and other pragmaticists have basically no opportunity to differentiate between scientific and non-scientific beliefs, for example religious beliefs. I don't see how the specific character of science as an enterprise that aims at truth in a non-trivial way can be maintained in this tradition. Popper's approach, however, allows for a desirable demarcation of scientific and non-scientific beliefs.

I would like to end my synopsis about scientific truth and tolerance with a tiny observation: Perhaps it is *not by accident*, but rather an expression of the common roots of tolerance in the modern philosophy of science in the tradition of the En-

19 *Cf.* H. Albert: *Traktat über kritische Vernunft* 5. Tübingen: J. C. B. Mohr (Paul Siebeck) ^{5}1991, p. 92.

lightenment that both Quine and Popper refer to Voltaire as an authority of tolerance, and quote the same famous passage from his *Dictionnaire Philosophique* when they reflect on 'tolerance in science':[20]

> What is tolerance? It is the heritage of our humanity. We all are *fallible* and easily fall for error; therefore let us *be charitable* with respect to our foolery; this is the first law of nature.

20 "Qu'est-ce que la tolérance? C'est l'apanage de l'humanité. Nous sommes tous pétris de faiblesses et d'erreurs; pardonnons-nous réciproquement nos sottises, c'est la première loi de la nature" (Voltaire: Tolérance. In: *Dictionnaire philosophique* (1764), ed. by J. Benda / R. Naves, Paris: Garnier 1961, pp. 401–407, p. 401). Both Popper and Quine were attracted by this "anthropological anchorage" of tolerance and made use of it in their philosophies of science. *Cf*., for example, K. R. Popper: *Vermutungen und Widerlegungen. Das Wachstum der wissenschaftlichen Erkenntnis* I, Tübingen: J. C. B. Mohr (Paul Siebeck) 1994, p. 23; *Auf der Suche nach einer besseren Welt*. München: Piper 1999, pp. 215–217; Quine: Tolerance. In: *Quiddities. An Intermittently Philosophical Dictionary.* Cambridge (Mass.): Harvard University Press 1989, pp. 206–210. Quine's *Quiddities* itself, taken as a literary form of philosophy, are also a reminiscence to Voltaire's *Dictionnaire philosophique.*