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THE JANUS FACES OF GOETHE: GOETHE ON THE NATURE, AIM, AND LIMIT OF SCIENTIFIC INVESTIGATION[1]

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Abstract

First will be investigated the trichotomy put forward at the Round Table discussion held at a Harvard conference on Goethe and the sciences in December, 1982 [2] : is Goethean science an alternative *to* or *within* modern science, or *no* alternative at all? It will be pointed to a surprising common feature in the seemingly contradictory views: in all three cases, however critical of Newton, Goethe is taken to have no doubts about the epistemic status of his own research. It will be thus focused on *this*, broader category, as opposed to a view (strengthening in the last decade) that treats Goethe as a fundamentally reflexive, sceptical thinker. It will be argued for the existence of such a polarity in Goethe's scientific and methodological writings. For want of a better labelling, it will be called the poles naïve and sceptic (not alluding to Schiller's dichotomy of naïve and sentimental), meaning, respectively, a non-reflexive, realist, ahistorical, 'scientific absolutist' , as opposed to a reflexive, historicising, language-conscious one. The existence of this polarity challenges the validity and shows the weaknesses of many of today's accepted narratives concerning Goethe's scientific endeavours and methodological utterances.

Keywords: Goethe, scientific methodology, history of science.

1.

How do Goethe's ideas on the nature, aim, and limit of scientific investigation fare today? Much has happened since the 1980's, when a piecemeal demonstration was needed to convince the reader [41, 48] that Goethe can readily be admitted to the Pantheon of scientists as well, not only to that of poets, if, indeed, such Pantheons need be established at all, as they are 'justified more on religious than on intellectual grounds' [39] . The last decades have greatly shifted the common view on the privy councillor's work on the sciences. Far from being neglected, Goethe's Farbenlehre is now part and parcel of most histories of sight and of vision science, even if a very peculiar one [1] Some earlier histories were also sympathetic towards Goethe, RONCHI for example [42] writes of an 'unfortunate situation in

[1] [37, 66].

which the voices of the two philosophers [Goethe and Schopenhauer] failed to have the effect they would have had at some other time.' WILDE, EMIL 1834–43 (1968) *Geschichte der Optik* I–II [20] devotes considerable space to Goethe's concepts. (pp. 153–225). Early polemical works siding with Goethe include [20], and [18]. The shift is a definite one, but the extreme polarities characterising the reception of Goethe's scientific writings have not disappeared, many still consider some of Goethe's scientific undertakings as 'tragic elements' in his otherwise great *oeuvre*[36]. In general it is interesting to see how the Goethe-reception throughout the last two centuries worked as a complementary indicator of the Newton-reception [46].

Still in 1949 a book written by Nobel-laureate Charles SHERRINGTON, published by Cambridge UP abounded in emotionally heated outcries , like: 'how Goethean and medieval [53] '. Less than 40 years later the same publishing house issued a book, where Dennis SEPPER, as the sober historian of science close-reading Newton's 1672 letter and Goethe's *Contributions to Optics,* concluded: 'I have come to believe that Goethe has an ampler conception of science than Newton, that he has a sounder notion of what an empirical methodology requires and a firmer grasp on the epistemological and philosophical issues involved…[2]' [49]. Where does the truth lie[3] among this multitude of interpretations, or, to reformulate the main question of this paper: how much are modern accounts of Goethe's scientific endeavours able to portray the admittedly complex undertakings of Goethe?

In the course of the paper, it will be first investigated the trichotomy put forward at the Round Table discussion held at a Harvard conference on Goethe and the sciences in December, 1982 [2], sketching three alternatives considering Goethe's achievement in the sciences. It will be argued, however, more in favour of a fundamental polarity (thus doing justice to Goethe's own conceptions?), that has been little pronounced and even less dealt with in recent years.

2.

If the scientific treatment of phenomena necessarily includes quantification, as was generally believed in the 19-th c., if it must be based on a strict separation of primary and secondary qualities, if it must have its roots in the atomistic, mechanical philosophy of preferably Descartes or Newton, and, as Helmholtz put it: 'a natural phenomenon is not considered in physical science to be fully explained until you have traced it back to the ultimate forces which are concerned in its production

[2] SEPPER 1988:x. Sepper is no 'partisan', and at other places is highly critical of Goethe's method, also claiming that Newton's scientific achievement far surpasses that of Goethe's

[3] *Maximen und Reflexionen* (MuR) 417, *Goethes Werk in 14 Bänden, Hamburger Ausgabe*, Hamburg 1953 (HA) 12:422 'People say, that between two opposed opinions the truth lies in the middle. No way! It is the problem that lies between them, what is unseeable, eternally active life, contemplated in repose'

and maintenance.'[4], then it is easy to conclude, Goethe is an utterly non-scientific thinker. He evidently subscribes to none of the above criteria, and, as his works do not belong to philosophy either, they must be pure art and poetry [60]. Indeed, many traits in Goethe's scientific undertakings reinforce this view. His whole theory of colours belongs to the outmoded modificationist tradition, though not in an Aristotelian sense. His science, unlike Newton's, or modern science in general, is clearly non-instrumental. In his works on morphology, he uses concepts alien to modern science, such as 'the verification of sap', which, though in the 18-th c. there was hardly any better theory around, is rooted in alchemical notions, just like his concept of enhancement (*Steigerung*)[5]. Goethe's alchemical inclinations are also well known, though he was obviously a less devout practitioner than Newton. He did not accept that colours are 'secondary' qualities in relation to 'primary', quantitative-physical ones, and that they are derived from the latter. He holds that 'light, colour are in principle as objective or 'outwardly real' as the quantitatively describable waves and movements taken account of by physicists' [22]. If the one is given 'objective' status, there is no reason to deny the same from the other. As the dichotomy of primary-secondary qualities was generally accepted in the 19-th c., when seeing the rejection of this on Goethe's part, many claimed that Goethe failed to grasp what 'scientific explanation' means. As Emil DU BOIS-REYMOND rather bluntly said: 'What was wholly lacking in Goethe was the concept of mechanical causality.'[6]

Though the ideals and aims of 20-th century science are clearly rooted in the 19th century conceptions rejected by Goethe, it has also become a commonplace, that at times unconventional approaches to science might prove exceedingly useful, as seen by the works of Oersted or Faraday. What's more, one is warned not to take the ascientific aspects of Goethe's science too seriously, as many obviously 'scientific traits' compensate for it. Though Goethe immersed himself in the world of alchemists[7], he also admits that he found it boring. He soon left behind popular alchemical writings like Willing's *Opus Mago-Cabalisticum* and studied the likes of Theophrastus, Paracelsus, and Helmont. Goethe's early, intensive preoccupation with alchemy left a lasting mark upon his image of nature[8] that met his deep need for wholeness in a world-view and satisfied his powerful imagination, but Goethe's alchemical inclinations, which cannot be denied, did not result in alchemical dogmas [59]. He regarded the popular alchemical notions as subjective distortions. The Christian philosophy on chemical premises (Paracelsus), 'Mosaical' philosophy (R. Fludd, A. Kircher, J. B. von Helmont), rational theories explaining fossils,

[4]quoted in [22] HELMHOLTZ, H.: On Goethe's Scientific Researches *Popular Scientific Lectures* (trans. E. Atkinson) London: Longmans, Green &Co 1893:45

[5]HA 13:72, *Goethe's Works*, I–XII, Suhrkamp (S) XII: 80, §28, also PORTMANN 1987, S XII: xi (Introduction by D. Miller)

[6]DU BOIS-REYMOND *Goethe und sein Ende*' Berlin: Vogt p.21 quoted in [22] p. 198

[7]HA 9: 341f

[8][54], for concepts also treated here see pp. 156–160. But the Hermetic, neo-pythagorean, alchemical influence on him was far inferior to that of Newton. ([19], the works of B. J. T. Dobbs)

volcanoes, etc. were of no use to him.

Goethe's blunder with the *Farbenlehre* is usually better known than his relative success in osteology[9]. He was certainly a pioneer of comparative anatomy, with many connections to the teleomechanic tradition, or rather Lakatosian research program flourishing in Germany in the early 1800's – somewhere between vital materialists and development morphologists [30, 31, 32].Today the Farbenlehre is considered to be a crucial work at the birth of physiological optics. Most interpreters of the 19-th c., apart from seeing a majestic poet in Goethe, treated his works in animal and plant morphology with at least some respect. Probably through Lorenz Oken and Richard Owen Goethe made his name even in the English speaking world: Darwin quotes him as one of his forerunners.[10] The scandalous *Farbenlehre* fared far worse,[11] though still had a significant influence on many[62]. But even if subscribing to the view that Goethe was an acceptable scientist of his age, we have to admit that he greatly fell short of being an exciting one. Blumenbach, Johannes Müller, or, indeed, several of Goethe's cohorts much more deserve the incredible amount of paper wasted on Goethe's scientific endeavours[12]. Instead, several attempts have been made to show, that what Goethe does in his scientific writings, is not science, as we now know it, but something rather different.

In the 20-th century the general reception shifted considerably, and many scholars today consider Goethe's *Farbenlehre*, and, in general, his notions about science as an *alternative* to modern – or to 19-th century - science, rather than as *non-scientific*. These accounts consider it less important that Goethe's discovery of the intermaxillary bone in humans found its way to the German compendia in the early decades of the 19-th century, rather, the main stress is on Goethe's alternative scientific methodology, his concept of experimentation, and of what counts as valid scientific explanation, thus being significant to contemporary philosophy of science. Goethe gives a highly sophisticated critique of the Enlightenment, esp. of Newtonian science 'being fully conscious of his running counter to the historical trend' [7], and lays the foundations of a phenomenological, holistic, non-reductionist science. Today the attitude, treating Goethe's notions as *pre*scientific lives side by side with the ever strengthening view that Goethe, apart from giving a valid critique of Enlightenment (esp. Newtonian) science, provides us with a *scientific* alternative.

A weaker thesis concerning Goethe's alternative science points to his – for

[9]Contemporary, important scientists, like Camper praised his work on walrus. for details see: [62]

[10]See the Introduction of the 4-th edition of the *Origins*, also in chapter 13 there is an allusion to probably Goethe's theory of plant-metamorphosis. [14]also [43]. That Goethe was no proto-Darwinian is clear, see [65, 25, 26, 65] on Haeckel, also 314–322, 380–431. It can generally be said that 'there is nothing whatsoever historical about Goethe's laws of form' [21].

[11]MACH writes about Goethe: 'dessen vollständige Unfähigkeit, einem quantitativen physikalischen Experiment zu folgen, und was noch schlimmer ist, die Unfähigkeit, sein eigenes Verständnis zu beurteilen', and many share his view [34]

[12]Günther Schmid in 1932 lists some 4 554 entries on Goethe and the sciences, FREDERICK AMRINE'S (1996) *Goethe in the History of Science*: Bibliography I–II (1776–1949 and 1950–1990) has about double that number. (Studies in Modern German Literature ; Vol. 29–30)

us mostly justified – critique of inductivist science, of the epistemic value attached to his own theories by Newton[13], and his showing how a mostly phenomenal description might be more useful in the sea of anomalies of colour phenomena[14]. In fact, when reading Goethe's *Farbenlehre*, it is surprising to see how few of the colour-phenomena Newton's theory actually explained, and one of Goethe's main points of criticism – that Newton was putting to the fore phenomena that are, and have long been, thought of as secondary [49] – thus seems more or less justified. This weaker alternative stance can rejoice in the fact that 'the natural sciences have in some respects been reorganised in ways that he [Goethe] hoped would come about'[48]

A stronger version of the alternative thesis holds that Goethe is venturing into previously unexplored territories: by building and developing new 'faculties', just as the mathematical faculty can be built, one is able to discover the lawful interrelations not of the mathematical entities but of the phenomenal world[15]. This claim will be considered later, suffice it to note here that, that provided it stands, the development of the scientist becomes an individual training and journey, and this individuality greatly threatens the generally accepted notion of science – in fact, it verges on the unscientific. We have come a full circle – from the unscientific, through the scientific, to the strong alternative view, dangerously close to being unscientific.

To decide which of these alternatives best fits Goethe's ideas on science, – though I strongly believe that the 1-st deserves the least credit – is a challenging task, but one, which I will not take up, as I consider the question ill-posed. What is at stake? Was he 'right' in his attack on Newton? Or does he deserve a more worthy place among his *Zeitgenossen*? Or rather are we to rehabilitate him as a forerunner of some of our today accepted ideas, or even a champion of a way of thinking yet to come? What is one to make of his criticism of contemporary scientific practice – are his embracing ideas similar to today's ecological movements, or just voicing ever-present sceptical worries that never ceased to exist in the long history of our written culture? And does this matter? Behind all three, previously sketched views, there lie adamant conceptions of the aim of the scientific enterprise, of history and of philosophy, that cannot be discarded easily. The ascientific label is derogatory, that of the 'normal scientist' somewhat uninteresting, while the alternative stance

[13] see e.g. *The Correspondence of Isaac Newton* 1959f, Cambridge UP (Corresp.) I: 96–97, the oft quoted passage (deleted in the final version by Oldenburg) in the famous letter read at the Royal Society in 1672, showing that for Newton his theory is 'not an Hypothesis but most rigid consequence …without any suspicion of doubt', also p. 293

[14] It would be a great mistake to believe that Goethe's theories are purely phenomenal. As in the case of the previously mentioned rectification of sap, (fn 11), or his conception of a *Nebenbild* (see *Farbenlehre* (FL) *Didaktischer Teil* (DT) §239, [62, 48]) in prismatic experiments, he certainly introduces purely hypothetical elements.

[15] As W. Schütz writes in 1821: 'Aristotle gives light and Plato soul, but Goethe gives both light and soul when he introduces us to Nature *Goethe's Botanical Writings*. 1989. Ox Bow Press, Connecticut, trans.: Bertha MÜLLER (Müller) p. 194 Schütz, or, as R. STEINER puts it: 'Goethe, in fact, begins where physics ends' 1988:236

has very unclear boundaries. Goethe is not as ascientific as some would like him to be, he uses complex optical paraphernalia, microscopes, carries out physiological experiments, and is in close contact with many of the scientists of his day. On the other hand, he does not stick as compulsively to phenomenal laws, as some accounts suggest, he praises chemistry for its bold hypotheses[16]. He is not just a synthetic, holistic thinker, in fact claims that Newton's premature synthesis – as opposed to his analytic approach (sic!) – is a main source of the Newtonian fallacy[17].

We are returning to some of the controversial issues later, but now it will be pointed to a surprising common feature in all the previously mentioned, seemingly contradictory views. In all the above cases, however critical of Newton, Goethe is taken to have no doubts about the epistemic status of his own research. Commenting on Kant's distinction of *intellectus archetypus* and *ectypus* (Cr. of Judgement, §77), Goethe writes: 'Why should it not also hold true in the intellectual area that through an intuitive perception of eternally creative nature we may become worthy of participating spiritually in its creative processes.'[18] This naïve or non-reflexive view can be embraced *without* having to chose between the three options sketched above, regardless of whether we applaud or mock his scientific endeavours. I will thus focus on *this*, broader category, as opposed to a view (strengthening in the last decade) that treats Goethe as a fundamentally reflexive, sceptical thinker.

It will be argued that there is a fundamental polarity to be found in Goethe's writings. For want of a better labelling, we will call these poles naïve and sceptic (not alluding to Schiller's dichotomy of naïve and sentimental), meaning, respectively, a non-reflexive, realist, ahistorical, 'scientific absolutist' , as opposed to a reflexive, historicising, language-conscious one. We are deliberately not using the concepts of 'Enlightened' versus 'Romantic' attitude to describe the Janus faces of Goethe, as to avoid the implication of a chronological ordering, though, admittedly, they would sound less clumsy. This dichotomy is intended as a fruitful anachronism. I will first investigate the non-reflexive, or naïve Goethe.

3.

The naïve, non-sceptical Goethe is far from being uncritical. He can be characterised by the rejection of the Newtonian method when applied in the realm of colour-experiences, the rejection of psycho-teleological reasoning, of abrupt changes in geological theories, of the mathematical treatment of certain phenomena, of theological reasoning employed in anatomical, osteological studies to claim special status of man among living organisms. But reading Goethe's morphological works, his early writings on colour (or even most of the didactic part of the *Farbenlehre*) suggest that one is reading the works of a non-reflexive scientist at

[16] Contributions to Optics I §16. Goethe, *Die Schrifte zur Naturwissenschaft*, herausgegeben im Auftrage der Deutschen Akademie der Naturforscher (Leopoldina), Weimar, 1947f. LA I/3: 11.

[17] Analysis and Synthesis. S XII: 48f, HA 13:49f

[18] S XII: 31, HA 13:30

the turn of the 19-th c., and one, who blindly subscribes to the ideal of inductive science accepted then, even if rejecting the idol of the inductive sciences, Newton as a noninductive impostor. At times, Goethe seems to be even too inductive or Baconian[19]. From his writings, it seems, however sceptical Goethe is towards what we might call the Newtonian ideal of science, he is not sceptical about the outcome of *his* scientific endeavours, and in this he is sharing the optimism of an Enlightened scientist. When he is critical, he is only so about the Newtonian ideal of science, not his own, as his outbursts of joy and the proud remarks describing his discoveries testify[20]. Instead of a detailed description and evaluation of these claims only some areas will be tackled: Goethe's attitude towards Bacon and the Baconian ideal of doing science, his attitude towards experimentation (especially towards crucial experiments), touching on his ideas on mathematics.

Bacon is one of the few philosophers who significantly shaped Goethe's thinking. Even in 1815, in a conversation with Sulpiz Boisserée, he admits that the thinkers most influencing him were Spinoza, Bacon, and Kant through Schiller.[21] Goethe has read Bacon's *Novum Organum* relatively early, probably under Herder's influence. He first mentions the 'idols' in 1772, he translates them virtually into German[22], and believes that Bacon has found a solution to get rid of the dialectical, teleological way of doing science[23]. In his letters discussing the famous essay on *'The Experiment as mediator between Object and Subject'* with Schiller he often mentions Bacon, and in a letter on January 17, 1798 he depicts a structure of science that is very similar to that of Bacon:

> 'The object of our work [i.e. investigating nature] would then be to demonstrate: (1) the *empirical phenomenon*, of which every individual is conscious in Nature and which is later elevated to (2) a *scientific phenomenon* by experimentation …and (3) the *pure phenomenon* now standing forth as the result of all experiences and experiments.'[24]

His hierarchy of these phenomena resembles Bacon's ideas: the empirical phenomenon stands for senses and particulars, the scientific phenomenon for Bacons middle axioms, and the pure phenomenon for general axioms.

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[19]The *Contributions to Optics* (LA I/3: 1–108), for example, not containing hypotheses, or any sign of a theory

[20]*Johann Wolfgang Goethe Sämtliche Werke, Briefe, Tagebücher und Gespräche.* Vierzig Bände. Deutsche Klassiker Verlag. Frankfurt am Main. (FA) 24:887 to Herder on 27th March, 1784 he writes that his discovery of the *os intermaxillare* in humans is incomparable to silver or gold. On 17th May, 1787 he writes from Naples: '…the Primal Plant [*Urpflanze*] is going to be the strangest creature in the world, which Nature herself shall envy me.' HA 11:324

[21]Steiger VI: 275, on 3. Oct. 1815: conversation with Sulpiz Boisserée, on the 'kleines Traktätchen de Idolis'. See more in [35] on p. 24 fn.

[22] For more details see [16]. In the list of *Idola tribus, pecus, fori*, and *theatri*, however, Fink writes *specus* instead of *pecus* and *forti* instead of *fori.*

[23]For the critique of teleological explanations Goethe also praises KANT (HA 13:28, S 12:29, CASSIRER 1963)

[24]MÜLLER (1989) p. 228 HA 13:25

One may say that the scientific phenomena and theories are not the ultimate aims of science: 'Hypotheses are the scaffolding which is set up before the building itself and which is dismantled when the building is completed. They are indispensable to the worker; but he must mistake on no account the scaffolding for the building itself.'[25] Goethe believed that experiments should not be designed to prove some pre-existent hypothesis and by following an empiricist method the phenomena that will 'speak for themselves'. In this sense he was undoubtedly more Baconian than Newton himself, as picking the experiments that Newton picked in his *Opticks* as the basis of his explanation of colour phenomena can hardly be imagined without him having some previous hypotheses in mind about the nature of light. Already his 1672 letter to the Royal Society only *appears* to be a chance observation, a brilliant example of the inductive method at work, as can be reconstructed from his earlier writings and the *Lectiones Opticae* [50, 51, 44].

To escape what seemed to him as the pitfall of Newtonian science, Goethe, starting from the 'pure phenomenon', developed the notion of the 'experiment of higher type', a point when, within our human limits, we can best understand nature. This 'super-experiment' is a series of experiments which 'directly adjoin and touch each other' amalgamating a series of experiments that should be the final stage in science[26]. Goethe sees all these experiments as the manifold aspects of the same experiment. This 'pure phenomenon' is reached by varying different conditions under which a certain phenomenon appears[27]. We grasp a single dynamic phenomenon in its multiplicity. A sequence of experiments 'constitutes as it were just one experiment, presents just one experience from the most manifold perspectives. Such experience, which consists of several others, is obviously a higher kind. It represents the formula under which countless single examples [Rechnungsexempel] are expressed.'[28] His attempt with the two *Contributions to Optics* is, to help his reader to re-experience this 'higher experiment'. The method of building up the 'higher experiment' is that of a mathematician's, it proceeds step by step, by 'deriving one fact from the preceding one', and by employing this method natural sciences, in Goethe's view, can reach the exactness and purity of mathematics.

This is curious indeed, as Goethe is usually taken to be the paradigm case of an unmathematical thinker. It is certain that Goethe was no arduous supporter of quantification and 'persistently neglected the quantitative' [10]. He claimed that mathematical descriptions are dangerous as: 'They are only symbolic and approximate representations, but they soon substitute themselves for the phenomenon itself and overpower and immobilise nature',[29] and also that 'Number and measurement

[25] MuR 554 HA 12:441

[26] see a recent account in [23]

[27] See more in *'Empirical Observation and Science'* HA 13: 25, S XII: 24

[28] HA 13:18. This is Sepper's translation (SEPPER 19688:70). See also S XII: 16. In the aforementioned letter to Schiller he calls this the *pure phenomenon*, and in his *Farbenlehre* the *Urphenomenon* (FL Didakt. Teil. (DT) §175. HA 13: 367, S XII: 194)

[29] LA, II, 6, p. 123 quoted by NISBET (1972) p. 49[35]

in all their baldness destroy form and banish the spirit of living contemplation.'[30] It is generally believed that Goethe's abhorrence of extreme quantification is rooted in his rejection of Newton's theory of white light and colours, as he thought that the highly debatable epistemological value Newton attributed to his findings was caused by his, for Goethe unjustified, trust in the power of quantifying phenomena. But against certain uses of mathematics Goethe was hostile long before he encountered them in Newton's writings. Already in the 1780's, in the short essay *Studie nach Spinoza*[31], he wrote: 'There have been attempts to measure the human being mechanically: painters have chosen the head as the best portion to use for a unit of measurement. But this cannot be done without creating tiny, indefinable distortions in the other parts of the body.'[32] But these fundamentally negative utterances are more aimed at highlighting the dangers of extreme symbolisation and the loss of phenomena. At other times Goethe is much more tolerant towards mathematics and its use, than is generally believed. He does not condemn Galileo for using mathematics, indeed holds that mathematical symbolisation – as it is founded on intuitive perceptions[33] – has the potential to become nearly identical in the highest sense with the phenomena that it represents, as a sort of *Urphänomen.* In the Historical part of the *Farbenlehre* Goethe writes that mathematics is especially useful, when it is employed to solve technical problems.

These positive remarks can explain the interesting fact that Goethe thought of his method as somewhat resembling mathematics. As Hjalmar Hegge expressed: 'His aim is to arrive at a comparatively small number of simple, well-defined elements, corresponding to the axioms of geometry, that is, expressions which are not further reducible to others, but express basic concepts in the system from which the other elements are derived.'[22], p.202. Goethe's method is to construct a theory where one link leads to another in a 'clearly discernible chain of inferences'[34]. But it is even more curious that many commentators think likewise, and believe that Goethe's method resembles that of mathematics. Heisenberg claims that there is a similarity between modern theories of symmetry and number and Goethe's elaboration of the morphology of colour phenomena[35]. But he was by far not the only one. Recently Sepper claimed that in a posthumous manuscript, Goethe derives straight-line boundaries from a curved boundary by performing what amounts to a continuous topological deformation of space (*ibid.*). Ribe drew an analogy between Goethe's modificationist model and differential equations.[41]

This has special relevance for the strong alternative thesis, as it supports the view that what Goethe is talking about is a *new kind* of lawfulness. When Goethe

[30] LA, I, 9, p. 367.

[31] Probably written in 1785 (HA 13: 564), before writing the *Contributions to Optics*. HA 13: 7, S XII: 8

[32] Note: historical reasons: transduction, harmonics not used frequently in scientific discourse.

[33] *Maximen und Reflexionen* in HA 12 (MuR) 646 'Mathematics is . . . an organ of the higher inner sense'. HA 12: 454

[34] ibid.

[35] quoted in [48]p. 75

asks: 'What is exact in mathematics except exactness itself? And this again, is it not a consequence of the feeling of truth,[36] he is not devaluing mathematics, but is only expressing his conviction, that this truth can be grasped by other means as well[37], not only by mathematics, which is only one manifestation of it. What is important, is how this 'truth' of the 'higher sense' can be acquired, and this is where a scientist must learn from a mathematician[38]. And, as our mathematical ability is, strictly speaking, not 'innate', but developed by systematic use, it is possible to develop a similar capacity in other, qualitative areas. Following this line of reasoning there exists today a whole research tradition following in the footsteps of Goethe[39].

Whether we discard this strong reading or not, Goethe's unusual conception of the 'pure phenomenon', or 'experiment of a higher kind' provides a basis for his critique of the then accepted role of experimenting. This 'experiment of a higher kind' is probably the most significant detachment from our train of thought in Goethe's scientific method. It presupposes continuity within the phenomenal world, as if, with infinitesimally small changes, one could depart from one experiment and arrive at the other. In this way the experiments are connected to each other, they cannot and should not be interpreted on their own, as this can easily result in misinterpretations.

But this is not the only unusual notion of Goethe's. Some others must have sounded just as perplexing to contemporary scientific ears, like: 'I venture to assert that one experiment, even several experiments combined, prove nothing; indeed, that nothing can be more dangerous than the attempt to confirm a theory by experiments; and that the greatest errors have arisen precisely because its dangers and its inadequacies were not realised.'[40] What he means here is, of course, the Newtonian *experimentum crucis* of 1672. The term *experimentum crucis* probably originates

[36] MuR 648 HA 12:455

[37] For Goethe this is called 'Schauen', a 'capacity to grasp', as it would be called in mathematics. Walter Heitler characterises this 'Schauen' or the 'Anschauende Urteilskraft' [perceptive power of thinking] as lying 'somewhere between observation and intuition' (quoted in [22],p.217. A good description of learning this method is Brady 1987.

[38] [8] and [66] both draw a comparison between Goethe's and Faraday's method, and mention Maxwell's note on Faraday's work: for Maxwell Faraday's work was mathematical in terms of the form of its experimental procedure, not in terms of the content of mathematics.

[39] See the volumes of *Goetheanistische Naturwissenschaft I–IV.* (ed. by W. Schad, Verlag Freies Geistesleben), or [4, 5, 2]for an overview of the theory of knowledge implicit therein see [29, 8, 45] However exciting these undertakings are, I believe they are based on an over-interpretation of Goethe. Though he does speak of 'developing new organs of perception', or powers of the soul (Seelenkrafte), he does not necessarily mean by this the rather strong reading of the above described tradition. At times it can be taken as something quite general, as in his letter to Zelter, 14. Oct. 1816, where he talks of a new organ gained by studying Linneaus – referring to the ability to systematise and order the manifoldness of nature - surely not the capability to see the archetypal plant!

[40] HA 13:15, MÜLLER 220–227, Twenty years later in FL Polemischer Teil (PT) he writes: 'We have no wish to begin by frightening our readers with some sorts of paradox, but we cannot refrain from maintaining that nothing can actually be proved by experiences and experiments.' FL-PT §30, DUCK 1994: 156. See also MuR 501, HA 12:434.

from Robert Hooke's *Micrographia*, who incidentally merges Bacon's *experimenta lucifera* and *instantiae crucis*.[41] When Hooke invented the crucial experiment, it was used to disprove a hypothesis of Descartes. Therefore, it was falsificatory in nature, not proving a theory right, but showing that it cannot be right, as it cannot account for the phenomena in question. For Newton, however, it became a tool that helped him to dispose of all rival theories of light and of colours – more specifically the modificationist theories current then. It is interesting to see that this dubious practice of *verifying* one's theory using a single (crucial) experiment has not raised more doubts in its time[42].

Goethe finds this unacceptable, and when rejecting Newton's theory, is also rejecting Newton's methodology, in which the *experimentum crucis*, the 'stretching of Nature upon the rack'[43] plays a crucial role. He gives a pronounced critique of crucial experiments that have verificationist implications, not a falsificatory *experimentum crucis.* For Goethe a single phenomenon, a single experiment can prove nothing; it is a member of a great chain, and is significant only within this context. In modern science the experiment is used to test or extend a theory or a theoretical proposition. The phenomena are merely given, the theory is that makes sense of them, gives them order. For Goethe, however, phenomena have intrinsic importance, and they bear certain affinities and relationships to other phenomena. [48],p.64.

Goethe – partly on Baconian grounds – developed an ideal of experimentation and phenomenal laws, that seemed to him to be epistemologically more justified than the view of 'Newtonian' inductive science received then. From this ground he criticised Newton's methodology. He also claimed that his own method is truer to mathematics (and thus can also be just as 'exact') than the mere juggling with numbers he charges Newton (somewhat unjustly). This reading , which I called the non-sceptical, or naïve reading, still dominates the views about Goethe's scientific writings, whether Goethe's notions are despised, openly ridiculed, politely smiled at, or seen as a promising scientific research program.

[41] CORRESP. I: 104 n. 10, SEPPER 1988:134

[42] In 1676 Anthony Lucas questioned Newton's theory. His first letter and the response to it were published, but his second wasn't, in which Lucas claimed that Newton failed to establish one of his premises, so the *experimentum crucis* is not a demonstrative proof, (CORRESP. I:104) questioning the minor of a syllogism, which, for Newton was a mere digression. (See also CORRESP. I: 189, 246, 184, 262). When de la Hire failed to verify Newton's experiments and Leibniz became interested in the topic, Newton took it as a challenge, and asked Desaguliers to verify his experiments. This shifted the attention from the serious methodological objection to the simple reproducibility of the experiments.

[43] FL Polemischer Teil (PT) §114, translation by DUCK 1994:171

4.

There is, however, another Goethe lurking around the corner, one, who has attracted much of the attention in the nineties. He is sceptical about the Baconian ideal of science, conscious of personal, cultural, epochal differences that can and do hinder scientific understanding. He argues for the existence of different modes of thought that can all be fruitful ways of approaching nature, but all fall short of being *the* fruitful way.

According to K. J. Fink, Goethe's ideas on scientific discourse are 'based on the view that individuals differ in their ways of thinking, indeed, he argued that each individual observes the edifice of nature in accordance with his particular situation and therefore 'the tower of Babel lives on, they are not to be united. Every man has his quirk, Copernicus had his too.'[44] Fink, by discussing in detail Goethe's utterances on history and the history of science attempts 'to shift discussion from the topoi of Goethe scholarship' [16],p.153, and he is not the only one[45]. These critics see a highly critical and language-conscious writer in Goethe. As these views are easily accessible today, a short *invocatio* of some of the main themes of these works will suffice.

At the beginning of the Polemical part of the *Farbenlehre,* Goethe writes: 'Everything that is an opinion about things belongs to the individual, and we know only too well that conviction depends not on insight but on will, that noone grasps anything but what is conformable to him and what, consequently, he is willing to concede.'(FL PT §30) The existence of different 'ways of conceiving things', or 'modes of conception' (*Vorstellungsarten*) is not only acknowledged by Goethe as one would think, but acknowledged as legitimate (FL-DT §751. S XII: 277, LA I/4:221).

And thus, strictly speaking: 'All phenomena are inexpressible, for language is a phenomenon in its own right which merely has a relationship to the others, but cannot reproduce them (i.e. gives identical expressions to them).'[46] Hence, for Goethe, **all** terminology in the sciences are symbolic, 'We are insufficiently aware that a language is, in fact, merely symbolic. People never consider sufficiently that a language is really just symbolic, just figurative [*bildlich*], never a direct expression of the objective world, but only a reflection of it. This is especially so when we speak of things [*Wesen*] which only touch lightly upon our empirical observation, things we might call activities rather than objects. In the realm of natural philosophy such things are in constant motion. They cannot be held fast, and yet we must speak of them: hence we look for all sorts of formulas to get at them, at least metaphorically.' That is *Vorstellung* which is always intimately bound

[44] Goethe LA II 6: 292 Gedichte WA 1/2/231 quoted in [16],p.90.

[45] see e.g. Theda Rehbock's description of Goethe's 'phenomenological grammar'(esp. Ch 8 in [40]). These undertakings, however, depart from Goethe's pronouncedly empirical approach, and focus not on 'Goethe's science', but, rather, on 'Goethe on science', highlighting the reflexive, and often skeptical utterances.

[46] see LA, II, 6, p. 186, translated in Nisbet (1972) p. 66

to *Darstellung*[47]. Therefore, for Goethe, theory is there in every seeing: 'For the mere glancing at [*Anblicken*] a thing cannot advance us. Every [directed] looking [*Ansehen*] leads to consideration [*Betrachten*], every consideration to reflection [*Sinnen*], every reflection to connection [*Verknüpfen*], and thus we can say that with every attentive look [*Blick*] at the world we are already theorizing.'(HA, 13:317)

Goethe's approach to science is pluralistic, accepting many ways of conceiving the phenomena, democratic, as opposed to being authoritative[48] Goethe sees the greatest danger to science in rigidifying these *Vorstellungsarten*, and raising them to an ontological status they do not deserve: 'This first and greatest mistake must be noted above all. For how can one hope for advances if that which is merely concluded, opined, or believed is allowed to be forced upon us as fact?'[49] He sees one of the greatest dangers in the unconditional acceptance of the work of previous scientists: 'When a science falters and comes to a standstill despite the best efforts of many researchers, it can often be seen, that the fault lies in a certain traditional concept of things, a conventional terminology, which accepts the great majority and follows unconditionally…' (S 12:53.). Dogmatism is one of the dangers that can destroy the sciences: 'A false hypothesis is better than none at all, for the mere fact that it is false does no harm. But when such hypothesis establishes itself, when it finds general acceptance and becomes something like a creed open to neither doubt nor test, it is an evil under which centuries to come will suffer.'(S 12: 49.) Although Goethe's words are generally taken to be against Newton and the Newtonian doctrine, it can (and probably should) be taken in a much broader sense[50]. To Schiller he wrote: 'Everyone holds that the separation of hypotheses from fact is extremely difficult, but it is even more difficult than one usually thinks, because every presentation itself, every method is hypothetical. Since from now on you as a third party will listen bit by bit to my presentation, you will better divide the hypothetical from the factual than I henceforth will be able to, because certain ways of conceiving things have indeed become inveterate with me and, as it were, facticized.'(LA I, 3:331)

Goethe admits in the Polemic part that an atomistic intelligence won't find anything wrong with Newton[51]. It's Newton's (and his followers') exclusiveness Goethe is against, and Newton's belief that his theory is right. Goethe is stressing the complex interrelationship between fact and *Vorstellungsart*, and with this move

[47]Quote from *Nachbarliche Verhaltnisse* in the didactic part: (FL-DT par. 752, S XII: 277, LA I/4: 221).

[48]Goethe 'wanted to establish a republic in colour theory so that a group of learned investigators of nature could voice their opinions', as opposed to the despotic and tyrannical Newtonian school [24].

[49]LA, I. 3:159 There are some striking similarities between Goethe's and Popper's utterances, see e.g. Popper, Karl 1981 'The Rationality of Scientific Revolutions' in: *Scientific Revolutions* (ed. Ian Hacking) Oxford UP

[50]Most recently Stephenson stressed this point, but he was by no means the first. This 'petrifying tendency' applies to *any* mode of thought, including Goethe's own. The danger is there, and however dynamic, ingenious, ground-breaking the original treatment of the phenomena was, they are all prone to degeneration.[58]

[51]FL PT §31, DUCK 1994:156

he is clearly shattering our picture of him as a naïve, enlightened scientist.

He also turns away from his beloved Bacon: after intensive historical studies for the *Geschichte der Farbenlehre*, he writes that Bacon is 'a Hercules... who cleanses a stable of dialectical dung, only to let it fill up with empirical dung.'[52] As Goethe realised that the Royal Society praises Newton's work as a prime example of Baconian science, his attitude towards Bacon radically changed. As he claims: 'I have never employed induction in my own private research, because I felt the risks involved in good time.'[53] His attitude probably changed during his intense study of the history of Optics. Goethe's notes from 1805 or 1807 state that 'Bacon's belief in induction without any prior theory is unsound, for it must lead either to an interminable compilation of empirical instances, or to a self-defeating generalization (for any generalization will necessarily be based on a prior selection from the data of observation).'[54] By 1807 he strongly criticised Bacon, and called him 'the chief of all Philistines, and hence so congenial to them'[55]. Somewhere else he said that 'Bacon had no faculty for ideas, and not even an inkling of it. He was born for the world of the senses, and battled his way along it like a Hercules'[56]. Goethe thinks Baconians fall prey to ill-considered theories or to prior hypotheses disguised as axioms and thus 'throw out the baby with the bathwater' by not realizing this.

It seems that Goethe was far from being a purely intuitive poet stumbling into and fumbling with scientific puzzles. What's more, we even have to discard the naïve scientist's image, as it is neglecting the many highly sceptical remarks uttered by Goethe. What is to do then? One possibility is to simply conclude that this obvious incoherence shows how unworthy of our attention Goethe was. But for many Goethe is a person too dear, and an attempt to give a coherent reading nearly always takes place. This can take the form of a developmental reconstruction,[57] but can also be achieved by stressing the affirmative 'scientific' utterances, what I have been calling the naïve side, or, respectively the sceptical side of Goethe (these latter two, obviously, run counter to each other). But are these our only options?

5.

Goethe is a very complex thinker, at times extremely hard to catch. Recently some attempts have been made to find Goethe's place on the Foucauldian map. As Foucault writes: 'The last years of the eighteenth century are broken by a discontinuity similar to that which destroyed the Renaissance thought at the beginning of the

[52] Jacobi 7 March 1808

[53] MuR 614 HA 12: 449

[54] Quoted in [35]

[55] Steiger 1988/V: 128, 13. Oct. 1807

[56] LA, II, 6, p. 63

[57] From the works cited here NISBET (1972) gives the development of Goethe's views on Bacon, Fink (1991) on his ideas concerning history.

seventeenth...'[58] Pratt, Brook (1996), or Crary (1990) claim that Goethe is on our side of this watershed, and they are in many respects right – as the numerous unusually 'modern' aspects of Goethe testify. However, can a historian of science leave unnoticed the many Aristotelian, hermetic, and 'outdated' elements also present in Goethe[59]? A lot of elements are at play, some more rational than others. Concerning Goethe's rejection of Bacon, for example Nisbet claims that Goethe understood the serious shortcomings of inductivism as a scientific method[35],p. 28. But is there no reason to believe (judging from the many emotionally heated utterances from Goethe) that there were other factors at play, too? Just as William Blake, one of the fiercest opponents of rationalism in England found in Voltaire first anally against his 'Trinity of Evil' of Bacon, Newton, and Locke, similarly Goethe saw an ally in Bacon against the much-despised dogmatic empiricism of Newton. And just as Blake turned away from Voltaire later on in his life, when he realized Voltaire's commitment to Newton, Blake's 'Sr. Isaac', and the philosophy implicit in the *Principia* and the *Opticks*; similarly Goethe turned away from Bacon and his inductive method when he realised that Newton, his 'Baal Isaak' is believed to be the master and champion of the inductive method. How rational is such a rejection, when, to our knowledge, Goethe didn't realise the implications of rejecting Bacon on his own hierarchy of knowledge (analogous to that of Bacon).

But how is then this complexity to be resolved? I have sketched two complementary (rather than rival) readings. The first is based on the truth claims of Goethe concerning his method, trying to reconstruct a positive heuristic aimed at achieving *some* kinds of (positive) knowledge about the world. The second is a sceptical Goethe, warning the scientists not to take truth-claims in general (*id est* neither his own) too seriously, embracing at times very pragmatic notions of scientific truth. The first reading offers a (possibly) new way of doing science, the second a critique of science. The first is the perspective of the scientist, the second that of a scientific critique – a philosopher? *Uniting* the two, and calling Goethe a *natural philosopher* [60], whose main aim is to see the world as an organised whole does not explain the fact that though the different faces of Goethe belong to the same man, just like the faces of Janus – they are actually looking in different directions.

This divergence is typical not only of Goethe's scientific studies. To take just one example, his *Elective Affinities* – also of interest for the History of Science – can be coherently interpreted both from a chemical and an alchemical perspective. Repeating the title of the German translation of Bergman's *De Attractionibus Electivis*, and starting with a very explicit description of a chemical reaction[61] the whole book

[58] FOUCAULT 1970:217

[59] In Crary's narrative Goethe ends up together with the likes of Maxwell and Faraday – scientists certainly belonging to the Newtonian 'academic bandwagon' (FL PT §148, DUCK 1994:177) – the line of inquiry so much detested by Goethe. He also treats Goethe and Schopenhauer as people hardly differing in their opinions, but this is rather problematic. See e.g. LAUXTERMANN 1990.

[60] [23] A similar treatment of Goethe (concerning his novel *Die Wahlverwandschaften*) in [55]

[61] I/4. HA 6:276. Goethe is using the letters AB and CD, just like Bergman. See also letter to Riemer, 24. June 1809.

offers an unambiguous chemical reading [27]. At the same time the 'red thread' of quicksilver and alchemy is also present throughout the magical *Kunstmärchen*[62]. The dilemma of whether to interpret the text *qua* chemical or *qua* alchemical, is similar to the dilemma in question concerning Goethe's scientific endeavours. And as a fruitful line of understanding of Goethe's still puzzling novel, the *Elective Affinities* is not to interpret the text as either chemical, or alchemical, but rather as 'a hybrid work which takes shape from various contexts, languages, and discourses concerned with *both* alchemy and chemistry'[63], similarly, the complex, multifaceted nature of Goethe's scientific work – that is open to diverse interpretations – necessarily loses many of its attractions, when viewed from a too restrictive and singular point of view. Instead, a consciously non-restrictive, broader perspective does more justice to Goethe's complex ideas. Knowing Goethe's abhorrence of purely theoretical systems, one might think that the consciously created multi-facetedness in his novels is also to be found in his scientific works.

It would come very handy if we could take for granted a definite development, or, at least, a shift in Goethe's as ideas – as chapters of a *Bildungsroman* about one of the pioneers of the *Bildungsroman* –, and thus show the shift from the naive to the sceptical Goethe. But these attempts are doomed to failure simply on account of the fact that such coherent, one-way development is not to be found in Goethe. Even very late in his life when writing about polarity[64], one of his most often used concepts, also employed in this essay, he writes: 'I had not failed to learn from Kant's scientific writings that forces of attraction and repulsion are essential properties of matter, and that, within the latter concept, the two are inseparable; this opened my eyes to the fundamental polarity of all things, which infuses and animates the infinite variety of the phenomenal world'[65].These are not the words of the 'sceptical' Goethe. On 24th May, 1828, Goethe, at nearly eighty writes: 'The missing capstone is the perception of the two great driving forces in all nature: polarity and intensification.'[66] Indeed, it seems, Goethe is consciously switching from one pole to the other, from the naive to the sceptic, from the analytic to the synthetic, from the systole to the diastole of thinking. It can easily be seen that this is not just incoherence. At the very end of the Polemic Part of the *Farbenlehre* he writes: 'this is not the end of the matter, however, for to a certain extent it will be taken up again in the historical part, ... This will involve more than merely

[62] REILLY (1997) shows how the text's colour imagery (or, rather, the lack of it – though being written while also working on the *Farbenlehre*) reveal the use of mercury metaphors, red (being the colour of cinnabar (HgS), and mercury(II)-oxide HgO) is always connected to Ottilie, and also how a double (mirrored) symbol of mercury transposed 90 degrees (>O++O<, or Otto, with German quotation-marks) is to be found in the character's name Charlotte, Ottilie, Otto/Eduard, Otto/Hauptmann, and the baby, Otto. Apart from alchemical elements, also many Platonic connections can be found [33].

[63] REILLY 1997:2

[64] About Kant's cosmogony he first learns through Herder, but later studies certain writings of Kant intensively (like the *Critique of Judgement*)

[65] HA 10:314. *Campagne in Frankreich*. Probably written in 1820 about his travel in 1792. Trans. In: NISBET (1972) p. 44

[66] S XII: 6, HA 13:48

polemicizing, for as well as impeaching the perpetrator and his pupils, the century which approved of and persisted with the doctrine, we shall also have to absolve them. It is to this milder task, necessary as it is to the completion and conclusion of the whole, that we now invite our readers, in the hope that they will undertake it with an open mind and in good faith.'[67] Here the naive Goethe (after attacking fiercely Newton for hundreds of pages) is standing hand in hand with the sceptical one (writing a history of colour-science, exceptionally detailed in its time, 'absolving' Newton)[68].

Thus, if we do not want to end up having several Goethes side by side (an unscientific dilettante, a 'normal' scientist, a forerunner of alternative science, a sceptical philosopher of science, one of the first standing on our side of the Foucauldian watershed, a hermetic thinker to the bone- (born unfortunately late) we better realise that the many faces of Goethe – albeit looking in different directions – belong to the same man.

FA *Johann Wolfgang Goethe Sämtliche Werke, Briefe, Tagebücher und Gespräche.* Vierzig Bände. Deutsche Klassiker Verlag. Frankfurt am Main.

HA *Goethes Werk in 14 Bänden, Hamburger Ausgabe,* Hamburg 1953.

LA Goethe, *Die Schriften zur Naturwissenschaft*, herausgegeben im Auftrage der Deutschen Akademie der Naturforscher (Leopoldina), Weimar, 1947-

WA *Goethes Werke*, Weimarer Ausgabe, Weimar, 1887–1919.

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Steiger STEIGER, R. (et al.) 1982–1996. *Goethes Leben von Tag zu Tag.* Artemis Verlag, Zürich, München.

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Müller *Goethe's Botanical Writings.*, 1989. Ox Bow Press, Connecticut (trans: Bertha Mueller).

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[67] [15]. Also in MuR 616 the two sides are together – here starting with the cautious, sceptical, and ending with the boastful.

[68] As for the ordering of the two: Goethe writes to Carlyle (13. April, 1830.), that he should first read the historical part (that is, even before the didactic part), as there 'you see there the subject approaching, halting, becoming clear, and again growing dim' *Correspondence Between Goethe and Carlyle* 1887: 182.

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