

The Janus Head of Bachelard's *phénoménoteknique*: From Purification to Proliferation and Back

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1. Introduction

One of the most productive notions introduced by Gaston Bachelard within the philosophy of science and technology is that of *phénoménoteknique*. Teresa Castelao-Lawless, for instance, describes it as “one of the richest concepts that Bachelard has to offer to contemporary philosophy of science and science studies in general” (Castelao-Lawless 1995, 45). With this concept, as we will see, Bachelard intended to highlight the constructive aspect of contemporary sciences. Or in the words of Bachelard: “Science does not correspond to a world to be described. It corresponds to a world to be constructed.” (Bachelard 1951, 46) An astonishing fact, however, is that several authors within science studies who endorse this constructivist claim are at the same time profoundly critical of the work of Bachelard. This is especially clear in the work of Francophone authors such as Michel Serres, Bruno Latour and Isabelle Stengers, who will be the focus of this article. For them, science studies and historical epistemology are radically opposed in their programs (see Tiles 2011). They are especially critical of another aspect of Bachelard's work, associated with his concept of the ‘epistemological break’. The result is a philosophical puzzle: how can one be a fan of phenomenoteknique while distancing oneself completely from Bachelard and historical epistemology?

The answer to this puzzle depends on how phenomenoteknique and the epistemological break relate to one another. In fact, there are several possible answers, each with its specific consequences. The first fundamental question is whether both concepts are intrinsically linked within the work of Bachelard. If they are in fact distinct, then obviously one can maintain this double stance. But, if they are linked, a second question pops up: does their link prove to be the fiat of the notion of phenomenoteknique, since the baggage of the break cannot be maintained, or rather a reappraisal of the notion of phenomenoteknique itself?

It is precisely this last claim that I wish to defend. Although superficially the work of Serres, Latour and Stengers seems to endorse the notion of phenomenoteknique while dismissing that of the epistemological break, their position is more complex and interesting. In order to articulate this more complex position, specific episodes of the history of Bachelardism must be taken into account. Firstly, it will be explored how the notion of the epistemological rupture, or rebaptized as the epistemological break, has mainly been taken up from the 1960s in the Althusserian school.¹ One finds the term in the work of Althusser, but also in that of his students. One could speak here, in fact, of Bachelard interpreted as following a *model of purification*: science consists in an act of purification, namely purifying oneself from ordinary experience and imagination.

Secondly, the notion of phenomenoteknique, on the other hand, has mainly gained ground from the 1980s, in discussions within fields such as Science and Technology Studies (STS) or in the work of authors such as Bruno Latour, Ian Hacking or Hans-Jörg Rheinberger. Here, in

¹ I'm ignoring here the more complex history, for instance on how this notion of a break has influenced the work of Michel Foucault, Pierre Bourdieu or even Thomas Kuhn. Focusing only on Althusserianism is a biased narrative, but it is precisely this bias that I want to highlight.

contrast, one should speak of the *model of proliferation*: science consists in an act of creating associations, creating connections, adding mediators rather than striving to an unmediated representation of reality. From this perspective, technology plays a crucial and positive role in scientific practices.

In the second part of this article, however, it will be argued that such a split up stance is hard to maintain, both in the work of Bachelard and in the work of more recent Francophone authors. In their work both concepts are interconnected and presuppose one another. The conclusion, however, is not that it would therefore be impossible to mobilize one concept without the other. One could of course stick to just one concept and ignore the other. The real conclusion is that it is possible to mobilize both concepts, and moreover that such an endeavour leads to a more complete and interesting picture of science. Within such a philosophy of science the models of purification and proliferation are combined. One can see them as two faces of phenomenotechnique, namely that of *technologies of control* and *technologies of negotiation*. Science, in this sense, is Janus headed.

2. The epistemological break and the Althusserians

Let me first start with the notion of the epistemological break, which played a crucial role in the reception of Bachelard's work in the 1960s and 1970s. Especially in France, Bachelard's work had mainly been taken up at that time by Louis Althusser and his students. They mainly focused on his philosophy of science, resulting in the stunning neglect of scholarship on Bachelard's books on the imaginary in France (see Wunenburger 2012).² But even if one sticks to his epistemological work, one notices another one-sidedness at work within Althusserianism, namely that of an exclusive focus on the epistemological break but a clear neglect of the phenomenotechnique. As we will see, this specific history is one of the main causes for this strange contemporary attitude towards Bachelard.

To understand how Althusserians mobilized Bachelard, it is important to have an idea what Bachelard himself had in mind with the notion of 'epistemological rupture'.³ A first thing to note is that Bachelard uses this concept in a very specific setting, both spatially and temporarily. An epistemological rupture always refers to specific periods of specific sciences, rather than science in general. It is for instance claimed for the case of chemistry in the 19th and 20th century (Bachelard 1953, 6-7).

Secondly, such epistemological ruptures are claimed in two senses, what could be called a *vertical* and a *horizontal* rupture. Either it refers to the vertical rupture between ordinary and scientific experience, or even stronger between imagination and knowledge per se. For Bachelard, this is often portrayed as a radical break, with two parts of the human mind that serve different functions and deserve their own analyses. "Between ordinary knowledge and scientific knowledge there seems to us a rupture that strict such that those two types of knowledge could not have the same philosophy." (Bachelard 1953, 224) Horizontally, the claim is also made that there are clear discontinuist shifts within the history of science. The most famous one is the 'new scientific spirit' (Bachelard 1934) starting in 1905 with the publications

² In France, the work of Bachelard is still too often reduced to a mere philosophy of science, while ignoring his books on imagination or his more metaphysical works. In the English speaking world, on the other hand, it is often the other way around, in the sense that his work is equated with his work on imagination.

³ The term itself is not systematically used by Bachelard, but present in the background. He does however use the term literally in *rationalisme appliqué* (1949, 104).

of Albert Einstein (Bachelard 1938, 9). Such a horizontal rupture refers mainly to historical shifts within sciences, that make progress not by accumulation but by rational reorganisation, for instance physics after the theory of relativity and quantum mechanics.

From the 1960s on, however, Althusser and his students started to mobilize this concept under the banner of an ‘epistemological break’ (*coupure épistémologique*) in order to grasp the scientificity of Marxism (Althusser 1965; Lecourt 1975; Balibar 1978). According to Althusser, there is a clear epistemological break in the work of Marx between his early, ideological work and his mature scientific work. By this break Marx discovered the ‘continent of history’, similarly how the Greeks founded the ‘continent of mathematics’ and Galileo the ‘continent of physics’ (Althusser 1965). Precisely to make this claim, he mobilizes Bachelard and historical epistemology, but in a very specific way:

To understand Marx, we must treat him as a scientist among others, and apply to his scientific oeuvre the same epistemological and historical concepts that we apply to others [...]. Marx appeared thus as the founder of a science, comparable to Galileo and Lavoisier. Moreover, to understand the relation that the work of Marx maintains with the work of his predecessors, to understand the nature of the break [*coupure*] or the mutation that distinguishes him from them, we must interrogate the work of the other founders, who as well have broken with their predecessors. The intelligence of Marx, the mechanism of his discovery, the nature of the epistemological break that initiates his scientific foundation, brings us to the concepts of a general theory of the history of the sciences, capable to think the essence of these theoretical events. That such a general theory does not yet exist but as a project, where it partly has taken shape, is one thing; that such a theory is absolutely indispensable to the study of Marx, is another. (Althusser & Balibar 1965, 16)

Althusser and his students thus reinterpret this notion of the epistemological break in a bold way, namely completely separated from Bachelard’s specific historical cases. Althusser’s aim was to establish “historical epistemology and the history of science as a regional field within the general science of history [i.e. historical materialism]” (Resch 1992, 181). This is, for example, clear in the 1967 lectures Althusser and his students gave for scientists, which consisted in the exposition of a *general* model of the relations between philosophy and science (see Macherey 2009). It resulted in an abstract view on scientificity, used and abused to criticize any opponent as ‘ideological’ (Althusser 1974).

A similar equation of the epistemological break with a general theory of any science whatsoever is also found in the work of his students. Michel Pêcheux and Michel Fichant, for instance, defend what they call the “discontinuous position”, which according to them “rejects the notion of 'knowledge' as continuous development, from ‘ordinary knowledge’ to 'scientific knowledge', from the dawn of science to modern science.” (Pêcheux & Fichant 1969, 9) The result is a radical a priori dismissal of all other philosophies of science as idealist ideologies, for instance the ‘continuist’ positions of Pierre Duhem or Léon Brunschvicg (Pêcheux & Fichant 1969, 74). Similarly, the distinction between ‘sanctioned’ and ‘lapsed history’ of science that Bachelard introduced at one point (see Bachelard 1951) becomes for them a general criterion to judge any history of science whatsoever.

And although such a project can be praiseworthy, it has had clear historical effects. The major result is that the epistemological break is transformed into an abstract general theory of the history of science (Pêcheux & Fichant 1969, 101). There is no room left for the specifics of the sciences and no word on the role of technological instruments is uttered. This reading has coloured the reception of Bachelard in France, but even more that of the Anglo-American

world. One of the first introductions to Bachelard translated into English was, for instance, a book by Dominique Lecourt, who reinterpreted the work of Bachelard from an Althusserian perspective (Lecourt 1975). The result is that other more recent literature on Althusser, when, discussing Bachelard, similarly only speaks about the epistemological break (e.g. Beston 1984, 24-30; Resch 1992, 178-181).⁴

My claim is that this Althusserian Bachelardism is mainly responsible for the typical image of Bachelard's work that is being criticized in the work of Serres, Latour and Stengers. Let us call this the *model of purification*. According to this model, science consists in a purification of the scientific mind from all 'epistemological obstacles' (see Bachelard, 1938). Such obstacles are to be understood as images arising out of human imagination or, in the Althusserian reading, reflections of the dominant ideology. Within this picture, science implies a different way of thinking, free from ideology or imagination, free from opinion and myth.

In their criticisms, these authors link this model of science with Bachelard's *La formation de l'esprit scientifique* (1938). The essence of such critique is perhaps best grasped in an early text by Michel Serres:

Let us be honest: one finds no psychoanalytic word whatsoever in the *Formation*, the language that it mobilizes, once one honestly listens to it, connotes a morality. The analysis is breath-taking: this is a *Traité de la réforme*. Of the spirit, the heart, the soul, the body, the academic world. I fear that the formation of the scientific mind in reality does not mean that one reforms the soul by freeing and purifying her. Listen to the advices of alchemy to the alchemists and ask yourself whether the advices of the epistemologist to the physicists and chemists, by accident, are not the same. (Serres 1972, 211)

In the same regard one must see, I think, the criticisms of Serres that "there is no purer myth than the idea of a science purified of all myth." (Serres 1974, 259) Latour, very similarly, states in an interview that "when I read Bachelard, *La formation de l'esprit scientifique*, I felt vaguely that everything inside was false, anthropologically false, that unreason could not precede reason in that manner." (Latour 2003, 66) Finally, Isabelle Stengers ascribes to Bachelard the "disqualification of the 'non-science' [...] associated with the notion of 'opinion,' which 'thinks badly,' 'does not think,' 'translates the needs of understanding.' Thus science is always constituted 'against' the obstacle constituted by opinion, an obstacle Bachelard defined as a quasi-anthropological given." (Stengers 2000, 26)

My claim is that it is a misunderstanding to see these criticisms as ahistorically aiming at the work of Bachelard. One has to understand the historical situatedness of these remarks, namely as a response to how Bachelard was being used by Althusserian inspired epistemologists in France. That they, for example, systematically use the notion of epistemological break (*coupure*) and not epistemological rupture already indicates that Althusserianism, and not Bachelard, is the target.

Serres has for example claimed that he broke with the epistemological tradition, claiming that "this milieu was not mine." (Serres & Latour 1995, 11) But it is important to note that Althusser

⁴ The effects of this reception are still seen today, for instance in the work of Steve Fuller. Fuller tries to link Latour and STS to Bachelard, but through the work of Lecourt which is "still the most relevant introduction" (Fuller 2000, 24). He concludes that "the academic Marxists perspective that gave Bachelard his widest reception in France [...] portray[s] scientists as a proletariat exploited by bourgeois philosophers who held them accountable to standards not of their own making" (Fuller 2000, 24-25).

was setting the tone of the debate around science in Paris when Serres was studying there. The Althusserians, for example, dismissed Jacques Monod's molecular biology as ideological idealism (see Pêcheux & Fichant 1969; Althusser 1974), while for Serres this was one of the most exciting new developments. Monod was Serres's personal friend and Serres read the manuscript for *Change and Necessity*, while "at the very end of the 1960s my professors of philosophy were still attacking Monod, and for unsound ideological reasons." (Serres & Latour 1995, 13) It is very telling that it is precisely in his text where he rebuts this Althusserian accusation of Monod as 'idealism', he speaks of Monod's work as a "non-Bachelardian epistemology" (Serres 1974, 57). Or as Serres formulates in a later interview, it was through his fascination with the novel concept of communication that he

parted ways, breaking with the vulgate shared by most philosophers of the time, which was broadly speaking a Marxist one (especially with Althusser at the *École Normale*), and which sought to foreground problems of production. I said no, the society of tomorrow will be a society of communication and not a society of production. (Serres 2003, 230)

Latour, in a similar vein, started his career in the 1970s, at the height of the Althusserian school. To study the sciences in France during that time, meant to relate oneself to authors such as Althusser, Foucault and Canguilhem, and their readings of Bachelard (see Schmidgen 2015, 58). Latour was initially not completely dismissive of Althusser's work, even admitting that in the 1970s, besides his fascination with Gilles Deleuze, he "had organized another reading group on *Lire le Capital*." (Latour 2001, 138)⁵

Nevertheless, he soon distanced himself from Althusser's position. In fact, in some passages Latour refers to Althusser directly, describing the 'epistemological break' as "Louis Althusser's favourite (and fully modernist) expression" (Latour 2010, 480). It was Althusserianism that "was going to purge the sciences from all external influence by separating them for good from the ideology." (Latour 2006, 208) And what was especially problematic was how according to "this tradition, rationality is exercised only through a continual asceticism that separates it from what makes it exist." (Latour 2004, 267n9) We thus find the model of purification here, once again, but ascribed to Althusser.

That Latou was mainly struggling with Althusser and not French epistemology in general, is also clear from the fact that Latour is quite positive about the work of other French epistemologists, such as Pierre Duhem or François Dagognet, which he sees as "dissident epistemologies" (Latour 2003, 72). In some interviews he even includes Bachelard in this tradition, claiming for example that "my tradition was rather that of Duhem and Bachelard, realist and rationalist, and passionate about the number of mediations that allows us to speak the truth" (Latour 2000, 140).

The clearest case, however, is the work of Stengers, who often refers to Bachelard and Althusser together, for example criticizing their view "that the 'historical' history of the sciences is

⁵ I thank this reference to Terence Blake. Söderberg (2017) goes even further and claims that STS as a whole field is deeply influenced by Althusserianism "because of its omnipresence in French intellectual milieus during the formative years of the STS discipline." (Söderberg 2017: 187) According to him, they are continuing Althusser's focus on multiplicity and his opposition to the Hegelian notion of 'totality' (see Althusser 1965). Although Söderberg claims that Latour is positively influenced by Althusser, this is not incompatible with my own claim. One could explain the specific criticisms of Latour I'm highlighting by the profound role Althusser played in Latour's formative years.

permeated by opinion, or, in Althusser's terms, by ideology" (Stengers 2000, 26). She is, in fact, quite reflexive about how it is the Althusserian reading that is at play here:

The term epistemological break comes from Gaston Bachelard, but its extraordinary influence in French epistemology appears to be linked less to the specific content Bachelard constructed for it through examples drawn from physics or chemistry than to the strategic function it played in domains he himself did not tackle. Having become a 'cut,' it allowed Louis Althusser to sanction the scientific character of Marxist theory. (Stengers 2000, 25)

It should be clear by now that to understand the specific attitudes of these authors to the work of Bachelard, the historical role of Althusserianism must be recognized. It was this Althusserian legacy that they were fighting with and their criticisms of Bachelard therefore do not reflect the whole work of Bachelard, but rather only one very narrow Althusserian reading of it. That Bachelard is not dismissed completely is precisely clear by looking to their attitude towards the concept of phenomenotechnique.

3. Phenomenotechnique in STS

In contrast to that the epistemological break, the notion of phenomenotechnique is still very popular. This is for instance clear by the numerous articles dedicated to this term and its history (Castelao-Lawless 1995; Rheinberger 2005; Chimisso 2008). Especially within fields such as Science and Technology Studies (STS) the term was taken up from the 1980s rather uncritically, to point at how scientific instruments are constructive and shape phenomena, rather than merely describe things out there. Steve Fuller, for example, even equates the epistemological rupture with "the temporary suspension of one's natural attitude to the world that results when a new instrument of perception is introduced to the lifeworld." He illustrates this with the example of "the telescope, which, once it became 'naturalized' in the European lifeworld, was taken to provide an access to the world as immediate as that provided by one's unaided senses. In short, the telescope became what Bachelard calls a *phenomenotechnique*." (Fuller 2002, 125)

Bachelard himself introduces this concept in his early works, around the early 1930s, in the article "Noumène et microphysique". He claims that within contemporary physics one has shifted away from the unity of experience as a starting point. The relevant phenomena are not to be seen as given, but rather as a (temporary) product of the instruments and theories of physics. Similar to the notion of a 'working hypothesis' he speaks of a 'working phenomenology' where "microphysics is no longer a hypothesis between two experiences, but rather an experience between two theorems." (Bachelard 1970, 15-16)

Bachelard will later make similar claims about chemistry, for instance when it started to synthesize artificial atoms and molecules that were not present in nature. He illustrates this by contemporary examples, such as technetium, an atom which was first synthesized in 1937, and did not exist in nature. Nature might stop with heavy atoms such as uranium, but science can go further, it can "make bodies exist that do not exist" (Bachelard 1953, 22). In this sense "the power of phenomenotechnical variation is a novel instance in philosophy. It doubles the real by the realized." (Bachelard 1953, 197)

For Bachelard it is a mistake to state that in these cases one is merely dealing with the actualisation of natural powers and potentialities. "It is in fact by a real abuse of language that one endlessly repeats that these techniques use natural forces. One would as well say that music is the use of natural noises or that wireless telephony is the use of electromagnetic waves. In

fact, it comes down in all these cases to an artificial synthesis.” (Bachelard 1933, 80)⁶ It is in this regard that he also makes his famous claim that “instruments are nothing but materialized theories” (Bachelard 1934, 16). This same idea is still found in his later work, such as *Rationalisme appliqué*:

The trajectories that allow the separation of isotopes in the mass spectroscopy do not exist in nature; one must produce them technically. They are reified theorems. We shall have to show that that which man makes by a scientific technique [...] does not exist in nature and neither does a natural range of natural phenomena. (Bachelard 1949, 103)

When Bachelard speaks of phenomenotechnique, thus, he mainly has in mind the fact that contemporary sciences do not rely on natural, given phenomena, but rather that they create novel and artificial phenomena by which they progress. Another form of discontinuity in Bachelard is at play here, not a discontinuity of mind but of matter: science also implies a break with ordinary phenomena.

What we find at work here, through the use of the concept of phenomenotechnique, is therefore a different model than that of purification. The scientific practices are similarly seen as discontinuist, as something radically different from other social practices, but not because they are purified, i.e. something has been removed or taken away. Rather, it is the other way around: scientific practices are discontinuist with other practices because *something new is added, new connections are made and the artificiality is increased*. It is therefore better to speak of a *model of proliferation*: to improve science, one should not purify it from imagination or ideology, but add connections. What kind of connections? Well precisely technical relations: instruments, recording devices, experimental manipulations.

It is this model that is fundamentally at work within authors such as Serres, Latour, Stengers and that is opposed to the model of purification they ascribe to this Althusserian Bachelardism. It is remarkable that it was Latour's first book (written with Steve Woolgar), *Laboratory Life*, that introduced the concept of *phenomenotechnique* to science studies:

It is not simply that phenomena depend on certain material instrumentation; rather, the phenomena are thoroughly constituted by the material setting of the laboratory. The artificial reality, which participants describe in terms of an objective entity, has in fact been constructed by the use of inscription devices. Such a reality, which Bachelard (1953) terms the ‘phenomenotechnique,’ takes on the appearance of a phenomenon by virtue of its construction through material techniques. (Latour & Woolgar 1986, 64)

Latour mobilized this concept to argue that a scientific fact such as the existence of TRF(H) was established in endocrinology not by purifying the mind of certain epistemological obstacles about hormones. TRF(H) could only be shown by introducing a whole network of scientific instruments, allowing it to become visible through mediations. Similarly, Pasteur could only establish facts about microbes by introducing more interventions within his laboratory, to allow microbes to show themselves as microbes (Latour, 1988). What differentiates scientific practices is thus not an act of purification, but rather a practice where new and robust laboratory

⁶ This comes very close to Hacking's claim of “the creation of phenomena. Traditionally scientists are said to explain phenomena that they discover in nature. I say that often they create the phenomena which then become the centrepieces of theory.” (Hacking 1983, 220) More recently, he has indeed claimed that his “position is strikingly similar to that evolved by Gaston Bachelard's (1953) ‘applied rationalism and technical materialism.’ ” (Hacking 2002, 44-45)

settings are constructed that allow ill-defined entities to become robust scientific facts (see Latour, 1987).

The role of interventions is so crucial for Latour, because for him all scientific phenomena are defined through the actions they perform. “[T]here is no other way to define an actor other than through its action and there is no other way to define an action but by asking what other actors are modified, transformed, perturbed, or created by the character that is made the focus of attention.” (Latour 1990, 59) Precisely by the capacity of phenomena to intervene they can make scientific theories stronger, by collaborating with and corroborating them. Scientific practices precisely aim to construct new and artificial relations with phenomena. Interestingly, Latour refers to Bachelard’s phenomenotechnique in this context to illustrate his point:

No matter how artificial the setting, something new, independent of the setting, has to get out, or else the whole enterprise is wasted. It is because of this ‘dialectic’ between fact and artefact, as Bachelard puts it, that although no philosopher defends a correspondence theory of truth it is absolutely impossible to be convinced by a constructivist argument for more than three minutes. Well, say an hour, to be fair. (Latour 1990, 64)

In later works Latour still refers to this idea, but rather under the banner of the slogan of “‘Les fait sont faits’: ‘Facts are fabricated,’ as Gaston Bachelard would say.” (Latour 1993, 18; 1999, 127)⁷

Similar perspectives can be found in Serres and Stengers. Serres starts from a comparable network approach as Latour and sees scientific practices as specific formations of relations (see Serres 1972). In *Les cinq sens*, he links this model of proliferation with the metaphor of the maze: rather than seeing mazes as unnecessary diversions or distortions of a straight path, a maze can be productive precisely by introducing more interventions. Such ‘distortions’ enables one to detect more, to know more. Rather than letting all phenomena through without distinction, a maze can differentiate between phenomena by narrowing and slowing them down, allowing the observer to become aware of new, subtle differences. To quote Serres extensively:

Let us change the discourse on method, let us optimize our journeys another way. We inherit our idea of the labyrinth from a tragic and pessimistic tradition, in which it signifies death, despair, madness. However, the maze is in fact the best model for allowing moving bodies to pass through while at the same time retracing their steps as much as possible; it gives the best odds to finite journeys with unstructured itineraries. Mazes maximize feedback. They provide a very long path within a short distance and construct the best possible matrix for completing a cycle. The best possible method for all kinds of reception, they are often to be found in sensation, whose problems they solve clearly. [...] Let us seek the best way of creating the most feedback loops possible on an unstructured and short itinerary. Mazes provide us with this maximization. (Serres 2008, 184)

Finally, within the work of Stengers you find a similar opposition between the model of purification and that of proliferation. For her, purification is an inadequate model, even “worse than a lie: it is an insult to experimentation” (Stengers 2006, 210). Such a model starts from the false idea that truth needs no technical assistance and that intermediaries are merely obstacles to the truth:

What is of the order of the truth requires no artifice to impose itself. Or with the same objection: if the efficacy of a proposition requires an art of cultivation, is not the door open to relativism? What

⁷ This formulation is nowhere found in the work of Bachelard in this literal sense. Closer to this formulation are certain remarks by Eduard Le Roy (see Le Roy 1899).

a horrible possibility! Must one not postulate that certain propositions have the power of imposing themselves by themselves, if we want to avoid the conflict of opinions and the arbitrariness of relations of force becoming an unavoidable horizon? The objection is all the more curious for coming from scientists who nonetheless know very well that a scientific interpretation can never impose itself without artifice, without experimental fabrications, the invention of which impassions them much more than ‘the truth.’ (Stengers 2015, 146)

She links this model of purification, “the desperate search for that which, being ‘natural’ would supposedly have no need of any artifice, [...] to the hatred of the pharmakon, of that whose use implies an art.” (Stengers 2015, 144) Against this model, she pleads for a model of proliferation that centers around the production of relations which make us able to detect and do anything within science. Technological mediators allow us to detect new things, but can also be risky since they often destroy or mislead as well. The model of purification dismisses artifices because of this ambiguity, while the model of proliferation acknowledges this ambiguity as necessary and even productive.

4. The Janus Head of Bachelard

In the previous parts we have mainly discussed how within the work of authors like Serres, Latour and Stengers a certain split within Bachelard was felt, created, developed or even cultivated. On the one hand you have the Bachelard of the epistemological break, a character often staged as the enemy. In contrast, the Bachelard of the phenomenotechnique is rather positively evaluated. The result is the strange situation where to prove a certain point one can mobilize Bachelard both as an ally and an adversary. To the extent that one can claim that there is (another) split in the work of Bachelard, this is indeed a possibility. But is such a split really present? Can one have the phenomenotechnique without the epistemological break?

In fact, one could claim that such a distinction is impossible to make within the work of Bachelard himself. In his books both notions often pop up together, at the same moment of the history of specific sciences. The ‘new scientific mind’ of which Bachelard speaks always comes down to the combination of a certain trust in a new way of thinking and a new way of using scientific instruments (Bachelard 1949, 78). Or as he adds, “it is only by a derealisation of the ordinary experience that one can reach the realism of a scientific technique.” (Bachelard 1949, 137)

It is an open question, however, how precisely both concepts are linked. A first way to understand the relation is by claiming that phenomenotechnique must be seen as a very specific side of the new scientific spirit that Bachelard sees at work. This new scientific mind is understood by him as constituted by the progressive freeing of the mind from the constraints of natural experience. Phenomenotechnique then boils down to a tool for such a liberation, namely the mind freeing itself from the constraints of given experience by being able to produce its own phenomena through scientific instruments. Phenomenotechnique is then merely a servant of the epistemological break. The only reason Bachelard speaks of it, according to this view, is because it contributes to letting concepts develop themselves within the mind more freely. Such a reading can be found in Serres’s work, when he claims that for Bachelard “the purification of the object – the suppression of its historical metamorphosis - is isomorph to the purification of the subject – the suppression of its unconscious, dreaming and instinctive prehistory.” (Serres 1972, 90) Phenomenotechnique, if we follow this argument, is just an elaborated trajectory to end with the same result: a purified mind that can think more freely without any obstacles.

Such an hypothesis is however problematic for several reasons. First of all, it seems to end up in a form of idealism, where an all-powerful mind constructs the objects of science. Bachelard himself, however, precisely contrasts his own position with such idealist positions on numerous occasions, partly as a reaction to his supervisor Léon Brunschvicg (see Chimisso 2008). Against this idealism he mobilizes notions such as ‘applied rationalism’ or ‘rational materialism’ in order to stress the dialectical side of the story, where thinking and doing are intertwined. “When one experiments, one has to reason; when one reasons, one has to experiment.” (Bachelard 1934, 7)

Secondly, it is also very important to stress that the notion of purification in Bachelard is not only at work at the level of the mind, but also of objects. Here Bachelard’s background in chemistry plays a crucial role, where purification also refers to a purification of substances and matter. In such a chemical purification materiality has a richer role to play than merely being an obstacle for thinking. The substances present themselves as forms of resistance, but also as powers to transform or to mix. In this context Bachelard criticizes the traditional notion of philosophical materialism, as a “materialism without matter” (Bachelard 1953, 3). It is too abstract, and does not take the diverse roles that matter can play in science into account. There are for instance different kinds of materialism, such as mechanical or chemical materialism, that imply different methods and approaches. Bachelard introduces the notion of ‘intermaterialism’, a materialism that focuses on how knowledge can be constituted within chemistry by letting different material substances act on each other, creating novel phenomena (Bachelard 1953, 16).

Materiality thus plays another, more active role. Purification here must be linked not with the mind, but with active instrumental interventions, and thus with phenomenotechnique. And it is here that Bachelard is clearly aware that such instruments have a richer role to play, besides mental purification, what we have called proliferation. The purification of substances does not merely aim to free the scientist from certain impressions, but also to increase our sensitivity to the different responses of the matter, its different resistances and its different actions. Moreover, Bachelard does not limit such perspective to chemistry, but equally applies it to physics and even biology. For him, for instance, tensor calculus plays a similar role in physics, since it is this “mathematical instrument that creates contemporary physical science as the microscope creates microbiology. There is no new knowledge without mastery of this new mathematical instrument.” (Bachelard, 1934: 58) Instruments like tensor calculus or the microscope make the scientist able to detect and articulate a whole range of novel phenomena.

Such an idealist perspective does also not take into account Bachelard’s attention to the role of specialization and fragmentation in science. Precisely the fact that scientific practices cannot all be reduced to one notion of rationality, but that we are faced with ‘regional rationalisms’ (Bachelard 1949, chapter 7), shows that one cannot separate the rationality of science from its object. In contrast to the above picture where phenomenotechnique only aims to free the mind from all obstacles, the opposite is at work here. Precisely the specific characteristics, linked to the specific field and object, are central in Bachelard’s picture. Phenomenotechnique does not bracken the role of the object, by reducing it to a mirage of the mind, but precisely opens up the dialectic between object and subject. Each science has its own rationalism because its object will have different properties and behaviors. Phenomenotechnique is therefore not a way to get rid of the particularities of the scientific object, but precisely allows us to articulate its specificities.

From this perspective one might almost put the above hypothesis on its head, and state that the epistemological break must be interpreted as a particular aspect of the phenomenotechnique. The latter notion than either refers to a technical act of purification, where indeterminate, phenomenal chaos is purified into a refined and rigid scientific fact. The epistemological break is then part of this aspect of phenomenotechnique. But at the same time phenomenotechnique also refers to an act of proliferation, where the instrumental interventions open up new fields of phenomena to be expressed, creating new questions or domains of phenomena.

However such a reversed view does not take into account that a similar correction must be made regarding the concept of the epistemological rupture as well, which is richer than that of the Althusserian epistemological break. As stated before, such a rupture implies both a vertical and horizontal dimension. This implies that such a rupture does not merely refer to a break with something outside of science, such as ideology or imagination. It refers to ruptures within scientific practices as well. Bachelard in fact stresses that it is not just one single break, but a matter of “perpetual ruptures” (Bachelard 1953, 207). It is in this context that Bachelard also uses the notion of ‘rectification’, referring to how a movement of revision and correction is central in the scientific practices. “[T]he scientific mind is essentially a rectification of knowledge, an enlargement of the frameworks of knowledge. It judges its historical past by condemning it. Its structure is the consciousness of its historical mistakes.” (Bachelard, 1934: 177)

From this perspective the central connotation of the notion of the epistemological rupture is not that of purification, but that of *transformation*. It does not refer to a strict protocol of how to break with imagination or ideology, as the Althusserian reading suggests. Rather, its core message is negative: ruptures are needed since there is no fixed starting point or, differently put, ordinary experiences and phenomena are never enough. A rupture precisely stresses the need of a constructive and productive act in order to form a meaningful but artificial setting in the laboratory where scientific phenomena can be articulated and subsequently form the basis of theories. In this sense, the epistemological break itself comes close to that of proliferation.

The conclusion, therefore must be that for Bachelard the epistemological rupture cannot be simply equated with purification nor can phenomenotechnique be seen as pure proliferation. Rather it is a question of degree, since both concepts imply purification and proliferation. It is, however, still possible to argue that both concepts can function as ideal types for these two aspects of science. Talking about the epistemological break highlights the role of purification in science, while the notion of phenomenotechnique evokes that of proliferation.

Bachelard’s philosophy is thus richer than portrayed in the above criticisms. And although not the focus of this article, similar claims can be made about the work of other French epistemologists, such as Georges Canguilhem. Again, in Latour’s criticisms of Canguilhem, Althusserianism might play an important role (e.g. Latour 1993, 92-93). It is, for instance, no accident that Latour only focuses on *Ideology and Rationality in the History of the Life Sciences* (1988), probably due to the notion of ‘ideology’ in its title and the fact that Canguilhem himself suggests that it was “under the influence of work of Michel Foucault and Louis Althusser, [that] I introduced the concept of scientific ideology into my lectures.” (Canguilhem 1988, ix)⁸

⁸ Moreover, these essays might also be targeted because they discuss the case of Louis Pasteur, one of Latour’s favourite authors. Canguilhem is criticized numerous times in Latour’s book on Pasteur (Latour 1988, 31, 75).

Three reasons, however, should make us sceptical towards seeing these criticisms as a general dismissal of Canguilhem and historical epistemology. First of all, it is problematic to equate Canguilhem's notion of ideology with that of Althusser (see Chimisso 2015). Secondly, at other moments Latour positively appreciates the work of numerous students of Canguilhem, such as François Dagognet, Jean-Jacques Salomon and Claire Salomon-Bayet (see Schmidgen 2015, 58-59).

But thirdly, and more importantly, Canguilhem's his own work goes beyond a mere endorsement of the epistemological break. For instance, in his book on the concept of the reflex, Canguilhem mobilizes the notion of phenomenotechnique to clarify the difference between the concept of the reflex between 1800 and 1850. This shift does not consist purely in a radical conceptual break, or a radical different way of thinking about the reflex and the body. In a sense, there is no pure epistemological break in the Althusserian way. There is, however, another crucial discontinuity to be highlighted, but one on the material rather than the cognitive level:

In 1850, the concept of the reflex is inscribed in books and in the laboratory, in the shape of apparatuses of exploration and demonstration, set up for it, and who would not have been without it. The reflex stops being only a concept and becomes also a percept. It exists because it makes objects exist that make us understand. With regard to the phenomenon of which it is claimed to contain the explanation, it is no longer only phenomenological, it is also phenomenotechnical. [...] And in this respect it must be maintained that if the reflex in 1850 is more scientific than the 1800 concept, because it has its place marked in so many ways in the laboratory of the physiologist and because it explains a greater variety of phenomena, both provoked and given, it is not more scientific because it would be better explained, that is to say, deduced. (Canguilhem 1955, 161)

The shift shows itself by the fact that one starts to find the concept of the reflex not only in books anymore, but in laboratories as well, showing itself as a useful concept to do things with, to create phenomena with. In Canguilhem, similar to Bachelard, a richer perspective is present that does take the role of techniques and experimental practices in science into account (see Méthot 2013).

5. Purification and Proliferation

If it is the case that the project of Bachelard cannot be split, does this then imply the fiat of all those double-faced scholars using one side without the other? As stated in the introduction, the possibility of using a crippled version of Bachelard is not excluded. But another option is also possible, namely that this indicates that by reintroducing a Janus-headed Bachelardism one can enrich our understanding of scientific practices. Moreover, as I want to argue in this final part, such a dual face of science is already present in the work of authors such as Latour or Stengers.

It might already be clear to the reader that this Janus head of Bachelard has an uncanny similarity with another Janus head, namely that of the sciences as described by Latour. In his early work he claims that scientific practices always have two sides: a *ready-made science* and a *science in the making* (Latour 1987). The *ready-made science* is science as portrayed in the handbooks, namely a passive nature out there described by a fixed scientific subject here. It is often a story about the scientists who break free from their beliefs to go to the given facts of nature out there. The *science in the making*, however, is completely different, namely one where scientists are faced with hybrid networks of humans and non-humans, the material settings where scientists tend to recruit and construct the relevant allies within their networks.

The scientific practices thus have two faces: one is the active proliferation of connections and associations, which, once these connections are rigid enough, is subsequently purified out of view. “The material setting both makes possible the phenomena and is required to be easily forgotten. Without the material environment of the laboratory none of the objects could be said to exist, and yet the material environment very rarely receives mention.” (Latour & Woolgar 1979, 69) It is in the context of the science in the making that Latour uses the notion of phenomenotechnique, as an adequate description of the creation of associations that is taking place. One can indeed compare science in the making to what I have called the model of proliferation. The ready-made science, on the other hand, comes close to the model of purification, namely the activity where one gets rid of all the necessary connections that make these phenomena possible, and present the scientific practice as an independent subject describing an independent nature.

In *We have never been modern* (1993) Latour will generalize these findings with the concepts of *purification* and *proliferation* (or what he also calls *translation* or *mediation*). Modernity consists in a Janus head, or as Latour states

The hypothesis of this essay is that the word 'modern' designates two sets of entirely different practices [...]. The first set of practices, by 'translation', creates mixtures between entirely new types of beings, hybrids of nature and culture. The second, by 'purification', creates two entirely distinct ontological zones: that of human beings on the one hand; that of nonhumans on the other. Without the first set, the practices of purification would be fruitless or pointless. Without the second, the work of translation would be slowed down, limited, or even ruled out. The first set corresponds to what I have called networks; the second to what I shall call the modern critical stance. (Latour 1993, 10-11)

The argument here is that to fully appreciate the perspective of Latour and Stengers, one has to go beyond a mere stress on phenomenotechnique as proliferation. In their philosophy of science a richer perspective is at work, and this can be articulated precisely by stressing how both sides of Bachelard are present. To tell the story about science one needs more than proliferation, one needs the model of purification as well.

In relation to this, it is a common misconception of the work of Latour that his project consists in an unmasking of the model of purification (epistemological break) as false in order to show the real face of science, namely that of proliferation (phenomenotechnique). In contrast with this interpretation, Latour again and again affirms that purification is not an illusion to be dispelled, since “it is much more than an illusion and much less than an essence. It is a force added to others that for a long time it had the power to represent, to accelerate, or to summarize - a power that it no longer entirely holds” (Latour 1993, 40). To unmask purification as an illusion would indeed imply making the mistake of purification oneself, since your critique would consist in a plea to purify us from these false ideas.

The work of purification is not a false story science tells about itself, but is itself part of the work that is necessary to construct successful scientific facts. Or put differently, the work of purification can be understood as a specific type of proliferation, namely as a specific way to create relations, namely interventions that radically isolate and purify a certain phenomenon. It is not purification nor proliferation on its own that allows scientific practices to function, but it is “[t]he link between the work of purification and the work of mediation has given birth to the moderns, but they credit only the former with their success” (Latour 1993, 41).

To retranslate this to the question of the phenomenotechnique of science, one could say that scientific practices are in need of two types of technologies to function. The first type is what one could call technologies of proliferation, or technologies of negotiation. An example of such a technology of negotiation would be the Keeling Curve, central to the research in climate change. The Keeling Curve refers to the famous graph that plots the amount of CO₂ in the Earth's atmosphere for the last 60 years. The Curve articulates a field of phenomena by which we can subsequently start arguing that it is climate change that caused the increase of carbon dioxide or not. But to start that argument, we need the curve first. The reason we have this curve is due to the hard work of Charles Keeling, who has been designing and using instruments precisely to make us become sensitive to the CO₂ levels (see Keeling, 1998). Or as Latour puts it, “[w]ithout Charles Keeling's observatory in Mauna Loa and the instruments that detect the carbon dioxide cycle, we *would know less*” (Latour 2017, 139). Other examples might be situated within so-called ‘exploratory experimentation’, such as the 19th century instruments to detect electromagnetic effects or particle detectors at CERN (Steinle, 2002; Karaca, 2017).

Such technologies first and foremost allow us to be affected by novel phenomena, without necessarily providing a fixed theory that can explain them. They constitute a framework in which we can start asking the right questions by firstly becoming sensitive to as much phenomena as possible, “as bodies learning to be affected by hitherto unregistrable differences through the mediation of an artificially created set-up” (Latour 2004, 209). To do science one has to be sensitive to the responses, the feedback of the phenomena one is studying. Phenomenotechnique as proliferation refers to the capacity to become sensitive through artifices, precisely as Keeling's many instrumental settings allowed us to. “I want more words, more controversies, more artificial settings, more instruments, so as to become sensitive to even more differences.” (Latour 2004, 211-212)

However, in scientific practices there are also technologies of purification, or technologies of control. Becoming sensitive to certain phenomena is not enough. You will only persuade other scientists if you are able to rigorously make the phenomena affirm a specific theory. Many technological settings in scientific practices precisely have this aim. Think of examples such as Arthur Eddington's classic eclipse experiments, aiming to decide between Newton's or Einstein's theory of gravity, or the Meselson-Stahl experiment, aiming to decide whether DNA replicates by conserving the whole, the half, or none of the strands of the helix.

The instrumental settings here, thus, do not want to make us sensitive to a new field of phenomena, but rather function to control the phenomena in a very narrow way, forcing the phenomena to choose sides between theories. The goal is here to purify the plurality of actions that phenomena tend to portray into a rigorous and narrow pattern that allow these phenomena to strengthen one theory by becoming its “reliable witness” (Stengers 2000, 167). In this sense, phenomenotechnique as purification play a crucial role as well, namely by disciplining phenomena, allowing the scientist to become their spokesperson. This is for Stengers the core of the experimental practice: “*the invention of the power to confer on things the power of conferring on the experimenter the power to speak in their name*” (Stengers 1997 165).

6. Conclusion

In this paper I tried to show how linking the concepts of phenomenotechnique and epistemological break enable us to give a more interesting picture of scientific practices, both present in Bachelard himself and in the work of authors such as Latour and Stengers. I have

argued against a too hastily dismissal of the epistemological break in favour of an isolated use of phenomenotechnique. The whole idea of an epistemological break has received a bad reputation, to a great extent caused by Althusserianism. In the work of Bachelard, however, one can find a more subtle way to deal with the role of purification in science.

This then led to a reappraisal of the role of phenomenotechnique in science. Although it sometimes seems as if scholars want to use the phenomenotechnique without the epistemological break, relinking these two concepts allows for a Janus headed interpretation of the notion of phenomenotechnique. Especially through a more fruitful and interesting reading of Latour and Stengers the result is a view on science where both the model of purification of the epistemological break and the model of proliferation of phenomenotechnique can play a role. More precisely, this led to the claim that within science technological interventions play two distinct roles, namely as technologies of negotiation, which aim to create new associations to become more sensitive to phenomena, and technologies of control, which aim to transform these still ambiguous phenomena into rigid scientific facts to support specific theories. Such a view goes against a tendency to overemphasize the role of proliferation and dismiss the role of purification. By reappraising the notion of the phenomenotechnique, one can however correct such an imbalance.

A final advantage of this view is that it can also open up a new appraisal of the political project associated with Latour and Stengers. From this reading, their project does not aim to unmask the whole model of purification as an illusion. The goal is not to get rid of any type of purification or epistemological break. Rather *they criticize the current model of purification, not purification in general*. What Latour has in mind when he introduces notions such as the ‘parliament of things’ is precisely the idea that the current way we tend to purify our phenomena is problematic. Problems such as the Anthropocene show that our current way of purifying phenomena is incomplete, must be corrected, elaborated, expanded.

This does not imply that science must be abandoned, or even that its conclusions must be dismissed. It only means that we have perhaps too much focused on technologies of control and have forgotten the importance of technologies of negotiation. We can regain all the scientific certainties, but only when we are fully aware of their social implications: if we accept the current way of doing science, its purification and proliferation, in what kind of collective will we live? “We may agree with your arguments, but we have to make sure that you are fully exposed to their consequences.” (Stengers 2005, 997)

7. Bibliography

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