

FRANCIS BACON ON POTENTIAL HEAT

Sebastian Mateiescu*

Abstract. The paper presents an analysis of the concept of potential heat and thus seeks to contribute some conceptual clarifications to Bacon's theory of matter. The starting hypothesis is that potential heat could be seen at first sight as an example of occult quality, for it has a hidden and non-manifest character which by definition is a specific feature of occult qualities. Yet, the thesis supported in the paper is that potential heat is not a genuine occult quality in Bacon's philosophy and it should rather be equated with the *motion of excitation*. Some important notions as occult qualities, primary and secondary properties, the reduction process, and their overall relationship receive some elucidation. An attempt is made to clarify the meaning of the term "potential" characterizing this sort of heat and situate this notion in the general framework of Bacon's theory of matter. One important consequence of this effort is the emphasis put on drawing a sharp distinction between the 'potential' and the 'actual' in Bacon's thought. Thus, the example of potential heat is taken to suggest that Bacon reaches a middle place between the Scholastics' positive reference to hidden dispositional qualities and the atomist's emphasis upon the necessity of reducing these properties to their categorical bases. This distinction is then exploited in resolving what are otherwise difficult puzzles in Bacon's conceptual framework and to further strengthen the role played by Bacon's cosmogony in his overall philosophy.

Keywords: Bacon's theory of matter; potential heat; occult qualities; primary-secondary qualities; potential-actual distinction; forms; cosmogony.

Introduction

Francis Bacon strongly opposed superstition and 'vain speculations' in philosophy, alchemy and natural magic.¹ Among his harsh critiques of superstition and speculations he sometimes involved the occult properties of things. He did not hesitate to reject explanation based on these properties "For these occult and specific properties (as they [the Scholastics] call them) are, together with sympathies and antipathies, for the most part corruptions of philosophy."² This being the case, how would the peculiar notion of 'potential heat' (Lat. *Caloris potentialis*), mentioned by Bacon in his work on the induction of the form of heat, fit into this scheme? In the

* Center For Logic, History and the Philosophy of Science, Faculty of Philosophy, University of Bucharest, Splaiul Independentei 204, Bucharest, email: sebastian.mateiescu@gmail.com

Novum Organum, Bacon refers to it before treating the different degrees of heat, and explicitly mentions that this heat is not available to the human senses at all: “First, then, I shall speak of things which do not feel at all hot to the touch, but seem to have only a certain potential heat, or *disposition and susceptibility* for heat. After that I shall pass on to things which are actually and tangibly hot and to their strengths and degrees.”³ Among Bacon’s examples of potential heat one can mention dung and carcasses of animals, which “carry potential heat”, herbs and other “secondary qualities of medicines” as Cordials, Abstergents and Aperients, sulphur, naphtha, and rock oil, quicklime or wine and strong waters, which all manifest “virtual heat.”⁴ What do all these instances of potential heat have in common? They all illustrate the properties specific for an occult quality, for they describe a hidden and dormant quality (of heat), which is not available to the human sense and which is manifest only in certain circumstances.

Potential heat is not discussed at all by Bacon’s commentators and one obvious question that comes to mind is: What is the place of potential heat in this system of thought? Moreover, can one interpret potential heat as an occult property, given its hidden and non-manifest character? As mentioned above, Bacon’s general reluctance to occult qualities already suggests a negative answer to the last question. However, it is worth inquiring into what the elements at which the features of potential heat can be reduced to. Finally, what is the meaning of this potential heat – and especially of the word ‘potential’ – in this usage?

The aim of this work is to come up with some answers to these questions and contribute some conceptual clarifications to Bacon’s theory of matter. The thesis championed in this paper is that potential heat should be interpreted as being the *motion of excitation*, which is nothing than one of the nineteen basic or structural motions in Bacon’s theory of matter, which combined as the letters of an ‘alphabet of nature’ give rise to all other motions in the Baconian universe.⁵ An analysis of the concept of heat and a tentative to render it as an occult quality is first presented. With the aid of some important quotes from Bacon, this examination is then set into the context of a debate about the distinction between primary and secondary properties. Finally, the paper concludes by contemplating the possibility of interpreting potential heat as a *motion of excitation* and explains this reading by operating the distinction between ‘actual’ and ‘potential’ in Bacon’s philosophy. The relevance of making this contrast is also justified by using it in solving a serious paradox Bacon’s view on potential heat could be faced with. Furthermore, this will enable to positively reflect on Bacon’s use of the distinction ‘potential/actual’ in his overall approach to ontology. Supporters of atomism like Locke and Boyle wanted to explain the hidden and the dispositional character of occult but also of secondary qualities by reducing them to primary qualities of particles, like shape, extension or arrangement etc. However, it is argued below that Bacon’s criticism of occult forms and qualities does not extend to the elimination from explication of any form of potential/non-manifest quality, for the motion of excitation to which potential heat can be reduced to represents just an intermediate step in the unfolding of matter’s general potentialities. Thus, the example

of potential heat is taken to suggest that Bacon reaches a middle place between the Scholastics' positive reference to hidden dispositional qualities and the atomist's emphasis upon the necessity of reducing these properties to their categorical bases.

Bacon's concept of heat

Bacon's analysis of heat in *Novum Organum* shows his famous method of induction at work.

By the end of this argument, Bacon concludes with identifying the form of heat with 'expansive motion', in the following way:

The Form or true definition of heat . . . [is that] heat is a motion, expansive, restrained, and acting in its strife upon the smaller particles of bodies. But the expansion is thus modified; while it expands all ways, it has at the same time an inclination upwards. And the struggle in the particles is modified also; it is not sluggish, but hurried and with violence. Viewed with reference to operation it is the same thing. For the direction is this: If in any natural body you can excite a dilating or expanding motion, and can so repress this motion and turn it back upon itself, so that the dilation does not proceed equably, but can have its way in one part and is counteracted in another, you will undoubtedly generate heat.⁶

What is the status of this motion with respect to the human sense? When, at the beginning of *Novum Organum*, Bacon starts speaking of his inquiry, he proposes an exploration into the hidden and latent processes of nature: "Now the Latent Process I speak of is a thing very different from what readily occurs to men's souls in their current afflicted state. For we do not mean certain visible degrees, marks or stages of a process in bodies, but actually an unbroken process which for the most part evades the sense." Is, then, the form of heat accessible to the human sense? Bacon's position is that heat is relative to individuals, for people vary in their appreciation of heat, and it is thus safer to think that what one can actually feel is the effect of heat upon oneself, but not its very form:⁷

As far as sense goes, heat is a respective thing, and relative to man, not to the universe; and it is rightly set down that heat is just its effect on the animal spirits. The effect is moreover intrinsically variable, since the same body can (according to the sense's condition) induce the perception of heat or of cold...⁸

Therefore, in order to arrive at the form of heat, which is hidden to the human sense, there is no other way but to follow the process of induction as exemplified by Bacon in the beginning of his discussion of the form of heat.⁹ In the first step of the process of induction, one has to draw up a table with instances and examples of heat – that is, a list which should specify as many occurrences of heat as

possible. Bacon's list starts with the sun's rays, fiery meteors, and after twenty-two instances ends with spices, hot herbs, strong vinegar, acids, and bitter colds.¹⁰ He continues his method of induction by listing some counter-instances to the entries already listed and then goes on with the third introductory step of his example of induction - to concoct a table of comparative degrees of heat – that is, to arrange instances in which heat is more or less present. For example, one of his suggestions at this point is to make an experiment to check the common accepted hypothesis that fish have low internal heat in comparison with birds, which are hotter.¹¹ Another intuitive example of how the degrees of heat can be felt is the one with animate bodies: “Amongst those that We can feel, the first degree of heat seems to be animal heat, which encompasses a wide range of degrees. For the lowest degree (as in insects) can hardly be felt at all, While the highest scarcely reaches to that of the Sun's rays in the hottest lands and climates...”¹² So animal heat comprises many degrees of heat, forming a ladder with its bottom rung occupied by the heat of insects, which seem cold to touch, and the top rung reaching to the rays of the sun, which manifest the highest degree of heat. Between these two limits many intermediate positions can be described. It is in this context of treating about the different degrees of heat where Bacon explicitly refers to potential heat as a sort of heat which is not available to the human senses at all: “First, then, I shall speak of things which do not feel at all hot to the touch, but seem to have only a certain potential heat, or disposition and susceptibility for heat. After that I shall pass on to things which are actually and tangibly hot and to their strengths and degrees.”¹³ And just before discussing this animate heat, which encompasses different degrees of heat, Bacon reflects on seven other contexts in which heat can be found in varying degrees of strength. He points out at this point that tangible and solid matter – like metal, wood, stone, sulphur, etc. – manifests no heat at all. Yet, it has a potential to be heated: “...as far as potential heats (potentials calores) and susceptibility to flame (preparations ad flammam) are concerned, we find many inanimate bodies very much given to it, like sulphur, naphtha, and rock oil.”¹⁴ All these substances are cold when touched, but nevertheless manifest heat in various contexts. Thus their heat seems to be context-dependent. This is obvious in some further examples adduced by Bacon on the same page:

Nevertheless all dung seems to carry potential heat, as when land is enriched with it. And the carcasses of animals likewise have such hidden and potential heat, so that in cemeteries where burials take place every day, the earth gathers a certain hidden heat which eats up any corpse newly interred far faster than does unpolluted ground.¹⁵

More generally, Bacon emphasizes that “Things which fatten the fields, as every kind of dung, chalk, sea sand, salt, and the like, have some disposition towards heat.”¹⁶ Therefore, potential heat appears as a “disposition towards heat”. It is not an actual heat, at least not one that can be felt by sense and so is hidden to the touch.

However, its dormant or latent character can be made manifest in certain circumstances, for, as we will further see, when one consumes medicines which contain potential heat, she or he will certainly feel this heat as an active and working heat within him or her body.

Now, the obvious question that comes to mind is: what is the meaning of this potential heat, given the fact that the form of heat is, as illustrated by the foregoing analysis, that of being an “expansive motion”? Also, can this potential heat be equated with an occult quality, which by definition is hidden to the senses, is dormant and manifests itself only in specific circumstances, as potential heat does too?

But perhaps one should rather start interpreting potential heat against Bacon’s theory of matter, which represents the background of his philosophical approach. According to G. Giglioni,

A cluster of interrelated concepts that are notoriously difficult to define (forms, simple natures, schematisms and natural motions) forms the backbone of his [Bacon’s] philosophical system. At the risk of simplifying a very complex subject, we might say that natural bodies are defined by forms, that forms are structural patterns determined by natural motions, and that natural motions result from the basic appetites of matter. Bodies, therefore, might be defined as crystallizations of natural appetites.¹⁷

The appetites of matter are therefore the basic ontological units in Bacon’s theory of matter and the driving forces of change in this universe.¹⁸ As Giglioni rightly points out, the

appetites are atomic and self-interested. They have no long-term knowledge concerning the purpose of their actions. The direction of their tendencies depends on the need to find immediate satisfaction for their desires and on matter’s overall tendency to defuse the tension that accumulates from conflicting motions... The primordial tension caused by (...) two basic appetites of matter – the motion of liberty and motion of union – was the original spark which began the various natural processes of corruption and generation...¹⁹

In this sense, should potential heat be equated with any of the appetites of matter, that is, with the active principles in Bacon’s universe? The appetites have a degree of inflammation – that is, a degree of desire – which determines or supplies a motion toward the fulfillment of the appetite in every body in which it occurs.²⁰ Since appetites have tendencies toward their fulfillment, one might be tempted to ascribe them a dispositional character and we saw that potential heat is dispositional in its core too. And indeed, Bacon often uses the term ‘virtue’ for designating these various appetites of matter.²¹

In Bacon’s view, it is crucial to distinguish between the different visible effects

of this huge hidden mechanism and, furthermore, to bring to light the specific effects of the actions originating in the appetites. In this sense, Bacon speaks about the 'reduction' of the 'imperceptible to the perceptible' by taking careful notice of the different effects various appetites can have:²² "It is evident that air, spirit and suchlike things which are fine and subtle in their entirety cannot be seen or felt, so that reductions are absolutely necessary when inquiring into them."²³

There are grounds to think that Bacon's proposal of reduction can also be read in the opposite direction. From an ontological point of view, the visible effects can in principle be reduced to the appetites which are their proper causes. This follows from the rule that, on the scale of subtlety, the difference between these elements and the visible effects or the properties of matter is only one of degree. Most of the time being inaccessible to the human sensory apparatus, they should be ontologically reducible to the appetites, which are the basic active elements of matter.²⁴ In other words, qualities like color or heat, that are uncovered for the human senses, are a way in which people experience the appetites, but in essence are nothing else than appetites – the fundamental actions of matter.

However, this type of dispositional character shared by the appetites of matter appears at first sight to be different from the one in the case of potential heat, because the latter is context-dependent while the former is not. Dung, rock oil, and all carriers of potential heat manifest it only in some specific contexts, while appetites, if they are dispositional in character, are such universally, regardless of the specific context.²⁵ To put it differently, the manifestation of the form of heat, i.e. the motion of expansion, does not wait for a specific context, although, seen as an appetite, it always has a latent tendency toward a fuller manifestation – that is, toward fully conquering the passive tangible matter it acts upon. So for the time being, it is worth inquiring into the first option of seeing potential heat as an occult quality.

Potential heat as an occult quality

Occult properties – such as magnetic attraction, for example, – were interpreted by medieval philosophers as hidden and unexplainable attributes of objects. As K. Hutchison observed in a remarkable essay dedicated to the interpretation of occult qualities in the seventeenth century, the term 'occult' "was part of the technical Peripatetic terminology used to distinguish qualities which were evident to the senses from those which were hidden. In this context it was the antonym of 'manifest.' Typical manifest qualities were tastes and colors, because they could be immediately apprehended by the senses."²⁶

One occurrence of Bacon's referring to occult qualities is in the following paragraph, in which Bacon negatively relates about the traditional approach to philosophy:

...when man reflects on nature in its free state, he meets it in the species of things animals, plants and minerals - and from this he easily falls for the idea

that there exist in nature certain primary forms of things which nature strives to bring out, and the idea that all the variety left over arises from obstacles and aberrations of nature which occur as she carries out her Work, or from the conflict of different species and the transplantation of one into another. And the first idea has brought us the primary elementary qualities (*qualitates primas elementares*), the second *occult properties and specific virtues* (*secunda proprietates occultas, and virtutes*)...²⁷

It is thus not hard to see that Bacon seems very reluctant to accept occult properties, which he associated in these lines with scholastic philosophy, a tradition he dismisses altogether with its principles made of elementary qualities and abstract forms. Bacon has no hesitation consigning these occult properties - invoked by the Scholastics as explanations of what cannot be otherwise explained by the means of the principles of their philosophy - “among the worthless short cuts of thought which the soul takes to avoid more taxing exercise.”²⁸ In other words, potential heat could be treated as an occult property, Bacon seems to say, only if one is not able to dig deeper into its composition. Therefore, he appears to be faced with a serious problem: he explicitly dismisses occult and dispositional qualities, accepting them just for the sake of vocabulary, and yet potential heat presents itself as such an important dispositional quality with some occult tone attached to it. Where is the way out of this dilemma? What meaning should be ascribed to potential heat? A solution might be found in acknowledging the link between occult properties and the distinction between primary and secondary properties, generally encountered in Renaissance philosophy but also in some passages in Bacon. One good example confirming this idea is the following quote in which Bacon explicitly refers to potential heat as being a secondary quality: “On *potential heats* consult the tables listing the *secondary qualities* of medicines...”²⁹

The distinction between primary and secondary properties was common to ancient philosophy and was used in the Renaissance philosophy in order to accommodate occult qualities to the intellect.³⁰ It is not difficult to grasp because it is fairly intuitive. Namely, in this view, there are some properties which are intrinsic to objects and which belong to objects independently of the human perception thereof – these are primary qualities. Then, there are some properties that people ascribe to objects in virtue of these properties’ relationship to the human perceptive apparatus, and these are called secondary qualities. For example, extension or shape are primary properties of objects – they characterize objects irrespective of the human perception thereof. However, color, like heat or odor and others, is often considered a mere consequence of the way objects act upon the human faculties of perception. Witness John Locke, one of the most important supporters of this distinction: “[Secondary qualities are] Such Qualities, which in truth are nothing in the Objects themselves, but Powers to produce various Sensations in us by their primary Qualities, i.e. by the Bulk, Figure, Texture, and Motion of their insensible parts.”³¹

K. Hutchison interestingly argued that the actors of the Scientific Revolution

did not totally discard occult properties, but rather reinterpreted them.³² It seems they refrained from relating the occult with the hidden or unknown character, because they explained all the properties by reference to unknown and hidden mechanisms. The direct consequence of this was that occult and manifest qualities had no independent ontological status – they were seen as effects of primary qualities and thus, as secondary qualities, in principle reducible to primary ones.³³

What is left here is to contemplate whether what seems at first sight to be an occult quality, i. e. potential heat, is also referred to by Bacon as being a secondary quality. The following paragraph would seem to confirm once more that in Bacon's thought there could be identified a strong connection between occult properties and secondary properties.

... occult properties and specific virtues ... belong among the worthless short cuts of thought which the soul takes to avoid more taxing exercise. But in the secondary qualities and operations of things - attraction, repulsion, thinning, thickening, dilatation, astriction, dispersal, maturation and the like - the physicians have produced better results; [-] and they would have produced better still if they had not corrupted these latter (...) by taking the two short cuts just mentioned (i.e. elementary qualities and specific virtues), [-] by reducing them to primary qualities and their subtle and incommensurable mixtures, or by not pursuing them further still and with greater and more thorough observation to their tertiary and quaternary qualities, and by breaking off their inquiries at the wrong moment. And virtues of this kind (and I do not say the same but similar) should not besought for only in medicines for the human body alone but also in the mutations of other natural bodies.³⁴

So occult properties and specific virtues are wrong operations of thought meant “to avoid more taxing exercise.” Had this work of searching for finer categories of things been done – Bacon seems to say - the supposed occult or hidden aspect of secondary properties would be explainable by reducing these secondary qualities to clear cut categories of primary qualities. In short, in order to be consistent with the Baconian system, it appears necessary to acknowledge that the universe is composed solely of primary natures, like air or fire, etc., but only their effects upon humans are accessible sensibly, and these effects may be called secondary properties. Bacon, however, insists that these should be reduced to primary qualities and here gives as example some minimal but good work in reducing secondary qualities done by physicians. In other words, the ontological status of secondary qualities and occult properties, potential heat including, is that of being nothing but primary qualities which tangible matter consists in. The method of the physicians is praised for its capacity to unlock some of the many hidden potentialities of matter. Potential heat is always, in principle, reducible to a primary quality and it is always the effect caused by the appetite which reflects this expansive motion *ad hominem*. Therefore, the supposed occult tone attached to potential heat would evaporate itself at the end of this

reductionist process for this occult aspect of potential heat would appear as caused by the lack of knowledge of what is the true primary quality to which potential heat should be finally reduced.

The same holds for all the secondary properties in the Baconian system of thought, as the following overview of A. P. Ramos' analysis of Bacon's natural philosophy suggests. In a penetrating discussion about Bacon's notion of form, A. P. Ramos seems to acknowledge Bacon's general commitment to dispositionalism – that is, the notion that the powers and virtues of things which wait for manifesting themselves as actual actions steam from the natures themselves. This, nonetheless, is seen as a step forward in comparison with Scholastic philosophy: “Thus, without abandoning the Form concept, Bacon is led to uphold its material translation in terms of ‘configuration,’ ‘structure’ or ‘texture’ of bodies, i.e. in terms of their internal disposition.”³⁵ But by fructifying Bacon's distinction between the status of properties in relation to the human sense (*ad hominem*) and independent from it (*ad universum*), Ramos further argues that this dispositionalism echoes the distinction between primary and secondary properties, which is generally valid for the whole Baconian system of thought. The example he gives is that of color, expressed in the terms of modern theories about color, according to which a subject's perception of color x' is commonly treated as one's perception of a wavelength x. Thus, “optical theory/wavelength x = interius, existens, ad universum” is paralleled – in Ramos' interpretation – by “natural language/color x' = exterius, apprens, ad hominem.”³⁶ This is indeed in agreement with Bacon's general stance on the limits of sense perception as described above. As Ramos indicates, Bacon's treatment of heat is also very suggestive in this regard, as Bacon uses different Latin terms for designating the thing in itself (*calor*) and the way it appears to human senses (*calidum*).³⁷ This gives weight to Ramos' conclusion that Bacon's reflections on the limits of the senses and his endeavor to give an answer to the Scholastic-Aristotelian theory of forms led him to a “tentative construal of the primary-secondary qualities distinction...”³⁸

Thus, the so-called distinction between secondary and primary qualities apparently has, in Bacon's philosophy, an important epistemological dimension. The true composition of secondary qualities is considered inaccessible because the appetites – which have a very subtle matter – cannot be accessed in the first place. And the distinction between primary and secondary qualities is made exactly in order to account for the limits of our senses.

In conclusion, it may be said that occult and dispositional qualities represent the human limitations in disclosing the pseudo-hidden elements of reality. In this sense, one can consider potential heat – which is relative to human and to other contexts – to be a paradigmatic example of a secondary quality.

The motion of excitation

At this point, since potential heat can be treated as a secondary quality and given that potential heat is characterized by a special type of dispositionalism – one which is always context-dependent – a serious challenge must be confronted. How can

such dispositionalism be clarified? Two options readily come to mind: either through tangible matter, that preserves the latent status of potential heat, or by reducing this heat – a secondary quality - to a specific appetite of pneumatic matter.

The first option, which is in agreement with much of Bacon's theory of matter amounts to saying that it is tangible matter which blocks potential heat and keeps it latent and context-dependent. After all, Bacon seldom thinks that it is because of tangible matter that humans generally cannot access the spirits in themselves. One should recall here that in the Baconian universe matter enjoys a double character, tangible and pneumatic.³⁹ Tangible matter obscures spirits, keeping them hidden from our sensory organs. It is also possible that the nature of spirits themselves is that of being inaccessible to human senses.⁴⁰ These spirits and the appetites of matter are locked in tangible matter and ultimately it is because of this that the power of their activity – in the present case, heating, – is mitigated. This line of argument, however, can be contradicted with a short reflection on the case of the potential heat instantiated in the plants used in medicine. This case is also a paradigmatic example of what Bacon tends to think about potential heat. As noted above, he exemplifies secondary qualities with reference to those accessed by the physicians in their practice, and it is contended here that potential heat can be placed among these secondary qualities. Exactly this is confirmed by Bacon in these lines:

On potential heats consult the tables listing the secondary qualities of medicines, and pick out from these the ones which work on the human body by dilatation, practically all of which are given below. Cordial's, which dilate oppressed spirits. Abstergents, which strengthen the expulsive virtue. Aperients in respect of the mouths of the veins and vessels... These in particular (and there are others) are rooted in the dilatation of the spirits, humours, juices and substance in the body by auxiliary spirits as well as by the tangible complexion present in these medicines, be they taken internally or externally.⁴¹

It follows from this example that there are some cases in which the spirit of heating present in these plants suddenly becomes more active when they are administered. It is only in such a context that the spirit is liberated and thus can manifest its hidden capacity by heating the body or its different parts (the palatable region, for example). But does this happen because the tangible matter that previously incorporated the spirit is destroyed? The following quote, written by Bacon in the same context in which he discusses the potential heat of plants, suggests a negative answer:

It is evident from the calendar glass what the sense or perception of hot and cold ordinary air is endowed with, as it can at once pick up such subtle differences and 1 degrees of them.⁴² Nor can it be doubted that the spirit in living animals has a far sharper perception of heat and cold, save that air is a

pure and clear pneumatic body with no admixture of tangible matter, while the perception of the spirits is blunted and numbed by the tangible body in which they are trapped. However, this obstacle notwithstanding, and as far as this perception is concerned, the spirits of living things seem to be more effective than the air itself. For so far it is not apparent to me that potential heat (which I am speaking of now) can dilate the air, while it is certain that it can do that to the spirits contained in the members of animals, as is evident (as I have said) in the secondary qualities of medicines.⁴³

What Bacon makes explicit here is that it is not tangible matter which essentially opposes the actual manifestation of heat, for the case of the calendar glass shows that air, which, by definition, is more subtle than tangible matter, is not sensitive to potential heat as tangible matter that composes the animal bodies is. The actualization of potential heat is thus explained by the action of attraction between similar spirits – the animated spirits are more active than the inanimate ones and are thus hotter:

... the vital spirit has in it a degree of inflammation, and is like a breath compounded of flame and air... this inflammation supplies peculiar motions and faculties... But the inflammation of the vital spirits is gentler by many degrees than the softest flames... and besides, it is largely mixed with an aerial substance... When therefore this rule declares that the vital spirits approach nearer to the substance of flame... they do this more than the lifeless spirits, and not that they pertain more to the nature of flame than of air.⁴⁴

By virtue of their hotness, these animated spirits attract the potential heat of the plants until they finally make it manifest. So it is not tangible matter that essentially explains the latent character of potential heat. What is then the cause of this special latent characteristic of potential heat? If we recall that, for Bacon, the appetites determine – or can be interpreted as synonymous with – some specific motions, than potential heat present in medicines might be nothing other than the *motion of excitation*, one of the nineteen basic motions of matter, which is also the cause of the ‘occult’ properties of a loadstone, as the following quote suggests:⁴⁵

Bodies do not just assimilate in a body or concrete state as, for instance, when flame generates flame, or flesh flesh, but also in the case of a simple nature or virtue, as when heat begets heat, and a loadstone... bestows verticity on iron. Now we call this diffusive or transitive force *motion of excitation* because it does not so much subdue bodies (which is what assimilation does) as appears to insinuate itself into the other body and excite within it a nature to which it previously had some inclination, but one hidden and dormant.⁴⁶

Thus, the equivalence between potential heat and motion of excitation is

illustrated by the special hidden and dormant characteristic of the latter. This approach also has the virtue of explaining potential heat with reference to a more basic appetite of matter, thus suggesting that there might be no essential difference between the potential character of potential heat and of general appetites. The so-called occult or context-dependent disposition of potential heat is thus reducible to the basic appetite – the motion of excitation – which is actualized by the appetite of attraction. In some contexts this appetite is easily fulfilled, in others not, but the essential point to make is that it is the same universal appetite that dominates not only potential heat but also potential cold, for they both share in the nature of the motion of excitation. The difference between heat and basic appetites would thus appear to be not one of ontology, but one of degree – at different times some of the appetites are stronger while other weaker.

The distinction between “actual” and “potential”

One important consequence of establishing the equivalence between potential heat and motion of excitation is the following conclusion: potential heat can be actualized in many ways – that is, the motion of excitation can be provoked in different manner by different appetites of matter. In other words, one should not think that potential heat can be actualized solely with the aid of the appetite of attraction. As the following example shows, the appetite of antipathy can equally actualize potential heat. Here is Bacon’s description of determining heat by sprinkling water on quicklime:

it seems that quicklime with water sprayed on it gets hot, either on account of the heat which was previously dissipated being concentrated (as I said before of plants stored up), or from the irritation and exasperation of a fiery spirit by the water, so that a certain conflict or antiperistatic action occurs. But which of the two causes is the right one will more easily appear if oil is poured on instead of water, for oil will do just as well to concentrate the enclosed spirit, but will not irritate it.⁴⁷

It is thus not hard to determine that it is water rather than oil which actualizes the heat of the quicklime and thus one should ascribe this process of actualization of potential heat to the appetite of antipathy. As Bacon clarifies when he talks about antiperistatic effects that take place in the middle region of the air as due to the fight of forces of heat and cold, coming respectively from the underground and from the heavens, it is the *motion of flight* which is responsible for these effects.⁴⁸ This motion of revolt is therefore the essence of the appetite of antipathy that irritates the potential heat in the quicklime and actualizes it. Without this distinction one might be tempted to equate potential heat with the appetite of union with connaturals or with the appetite of antipathy, depending on the context. But this would present a strange situation, in which the same disposition for heating is manifested by two quite different appetites that are actually antagonistic in their nature. It is obvious that this

disposition could not be identical with both of these appetites since the two are so different in their character. However, the sharp distinction between the potential (the motion of excitation) and the forces which actualize it (appetite of union or appetite of antipathy) resolves this paradox in a straightforward manner.

One important consequence of this argument is that *disposition* must be something in itself and this in its turn suggests that the appetites of matter have an irreducible potential character embedded into them. Thus the reduction of potential heat to the basic appetite of the motion of excitation is similar only in form but not in its content with the reduction of dispositions and secondary properties to the *categorical* properties of bodies professed by the seventeenth atomists.⁴⁹ Locke or Boyle tended to reduce dispositions to the basic or categorical properties of bodies such as shape or extension but treated the former as being just relative to the observer.⁵⁰ As has been argued above, potential heat appears not to be relative to the observer but relative to other appetites that actualize it. In other words, the 'potential' character of this sort of heat is not only due to the limits of the senses, a restriction which we saw is nevertheless valid in Bacon's philosophy, but it has in its core a potentiality which waits to be actualized by the action of some specific appetites. Therefore, the distinction between 'actual' and 'potential' helps resolving not only what otherwise would have been awkward puzzles for Bacon's philosophy but it also sheds new light on the role of potential and dispositional qualities in Bacon's ontology. Rejected by the atomists for having a strange and occult character, potential qualities found themselves a place in Bacon's philosophy, one which departs in its details from the former approach and still keeps itself distant from the Scholastic justification based on substantial forms and quasi-substantial attributes.⁵¹ Bacon thus seems to have reached a middle place between these two extremes by proposing a different type of reduction of the dispositional qualities, one which still allows working with the distinction between 'actual' and 'potential.' The important role of contrasting between these two notions would become more transparent if one looks at Bacon's cosmogony.

According to Bacon's accounts of the origins of the universe, primary matter or Cupid or 'the atom', as it is alternatively called, enfolds all the potentialities of matter. As S. Weeks nicely put it, "the primordial act of creation involves a process of making the enfolded manifold. Cupid's appetitive power draws the primary particles together, and from the multiplication of this combinative power <all the variety of things arises and comes into being [conflatur]>."⁵² This potency successively unfolds itself up until it produces the first *substrata* of matter, called the schematisms of matter and from these conglomerations of forces simple and antagonistic motions emanate and give birth to primary natures as "oily and watery, fat and crude, inflammable and non-inflammable, flamy and airy, stellar and pure ethereal, and finally ... sulphur and mercury" in their turn.⁵³ At different levels in this chain the primary natures produce new schematisms and motions which finally end in a dynamic stability corresponding to macroscopic bodies, which can consist of tangible and pneumatic matter.⁵⁴

Therefore, primary matter or Cupid, originally conceived as being without cause, encompasses two inseparable facets, that of *substratum* and that of *potency*: “the primary essence, power [vis] and Cupid of things is without cause.”⁵⁵ Cupid’s appetitive power unfolds all of matter’s potency the distinction between ‘actual’ and ‘potential’ in the case of heat match this scheme to.⁵⁶ Potential heat would thus correspond in this system to a specific step in the process of unfolding of the potentialities of heat. Only through Cupid’s work of love or *concordia* is this potency fully actualized, that is, in our case with heat, by the work of the appetite of union with connaturals the potentialities of heat are fully unfolded to their essence, which is the ‘expansive motion’. However, as potency, potential heat is richer than ‘expansive motion’ for it has no final bond: it can equally be actualized either by motion of flight or by motion of union or possibly by the work of other appetites, whereas from the point of view of the process of unfolding, the form of heat cannot be restricted in its essence by any other constraint. The form of heat - the ‘expansive motion’ - is thus the final constraint one can find in the chain of the unfolding of heat. Shall one thus conclude with S. Weeks here that the meaning of forms in Bacon’s natural philosophy is that of being “the limitation of nature’s power that gives rise to a given simple nature”, in our case, the nature of heat?⁵⁷ The analysis of potential heat presented here seems to fit in well with this interpretation but there is no doubt that further important clarifications would be generated by a similar study of the notion of potential cold.

Conclusions

The goal of this paper was to come up with an analysis of the concept of potential heat and of the possibility to interpret it as an occult quality. The arguments presented in this work brought evidence for the idea that the two terms should be kept separated and the thesis proposed was that that potential heat should be interpreted as being nothing else than the *motion of excitation*.

At the start some basic elements of Bacon’s theory of matter were established, which were then inscribed into Bacon’s method of induction. This method was then exemplified by the study of heat, followed by a detailed account of potential heat. Some important notions as occult qualities, primary and secondary properties, the reduction process, and their overall relationship received some elucidation. The paper thus tried to bring to light some unstudied key notions in Bacon’s theory of matter. Here an attempt was made to illuminate the meaning of the term ‘potential heat’ and situate this notion in the general framework of Bacon’s theory of matter. One important consequence of this effort was to highlight the importance of drawing a sharp distinction between the ‘potential’ and the ‘actual’ in Bacon’s thought. As mentioned above, this distinction helps resolve what are otherwise difficult puzzles in Bacon’s conceptual framework. But perhaps more importantly is the weight this distinction can give to the role played by Bacon’s cosmogony in his overall philosophy and to the possibility to interpret the forms of nature as constraints or restrictions of the potentialities of matter.⁵⁸

Acknowledgements. I am indebted to Dana Jalobeanu and to the anonymous referee who made useful comments and suggestions on an earlier draft of this paper. I also benefitted from helpful indications by the participants to the workshop “The arts of experimenting between practices and forms of writing: The case of *experientia literata*,” Faculty of Philosophy, University of Bucharest, 6-7 December 2012. I would also like to thank Ilya Kharin for his help to improve the style of writing in this paper. Research for this paper has been supported from the grant CNCS PN-II-ID-PCE-2011-3-0719, *From natural history to science: the emergence of experimental philosophy*.

References

- ¹ For details on Bacon’s general reluctance to occultism and superstition, see Rossi, P., *Francis Bacon: From Magic to Science*, trans. S. Rabinovitch (London: Routledge and Kegan Paul, 1968) and Walker, D. P., *Spiritual and Demonic Magic from Ficino to Campanella* (Pennsylvania: The Pennsylvania State University Press, 2000), 199-203.
- ² Bacon, F., *Novum Organum*, in *The Oxford Francis Bacon Edition*, ed. G. Rees and L. Jardine (Oxford: Clarendon Press, 1996) volume XI, 437 (hereafter OFB).
- ³ Bacon, F., OFB XI, 237 (emphasis added).
- ⁴ See for more details Bacon, F., OFB XI, 233, 239; *Historia densi et rari*, OFB XIII, 107; *Sylva Sylvarum, The Works of Francis Bacon*, ed. J. Spedding, R.L. Ellis, D.D. Heath (Stuttgart-Bad Cannstatt: Friedrich Frommann Verlag—Günther Holzboog, 1963-1994 [1857-1874]), 14 vols., IV, 319-330.
- ⁵ See for details Bacon, F., *Abecedarium nouum naturae*, OFB XIII.
- ⁶ Bacon, F., *Abecedarium nouum naturae*, OFB XIII.
- ⁷ Bacon is committed to a general limit of the human sense in perceiving the true causes in nature: “By far the greatest hindrance and distortion of the human intellect stems from the dullness, inadequacy and unreliability of the senses, so that things which strike the senses outweigh those which, even if they are more important, do not strike them immediately. Reflection therefore almost stops where sight does, and so things invisible attract little and no attention. Thus every operation of the spirits enclosed in tangible bodies lies hidden and escapes to men’s notice...” (Bacon, F., OFB XI, 87).
- ⁸ Bacon, F., OFB XI, 263.
- ⁹ See for details Gaukroger, S., *Francis Bacon and the Transformation of Early-Modern Philosophy* (Cambridge: Cambridge University Press, 2004), 145-148.
- ¹⁰ Bacon is aware that other instances can be added to this list. For details see Bacon, F., OFB XI, 217-219.
- ¹¹ For details see Bacon, F., OFB XI, 241.
- ¹² Bacon, F., OFB XI, 241.
- ¹³ Bacon, F., OFB XI, 237.
- ¹⁴ Bacon, F., OFB XI, 239.
- ¹⁵ Bacon, F., OFB XI, 239.
- ¹⁶ Bacon, F., OFB XI, 239.
- ¹⁷ Giglioni, G., “Mastering the Appetites of Matter: Francis Bacon’s *Sylva Sylvarum*”, in *The Body as Object and Instrument of Knowledge: Embodied Empiricism in Early Modern Science*, ed. C. T. Wolfe and O. Gal (Dordrecht: Springer, 2010), 153.
- ¹⁸ See Giglioni, G., (2010), 151: “... the notion of appetite is at the very center of Bacon’s meta- physics of matter.”

¹⁹ Giglioni, G., (2010), 156-164.

²⁰ In the *Novum Organum*, (OFB XI, 385-413) Bacon lists a number of nineteen basic motions of matter, out of which other motions can be derived: motion of resistance, connection, liberty, hyle, continuity, of profit and want, of greater and lesser congregation, magnetic motion, motion of flight, of assimilation, of stimulation, of impression, of excitation, of configuration, of passing through, royal or political, of rotation, of trepidation, of rest. And it seems there isn't always a clear cut distinction in Bacon between spirits, appetites and motions. For example, Bacon occasionally treats appetites and motions as synonyms, as when he refers to the *motion of continuity* being an appetite: "But most of all, this appetite displays itself if you try to carry discontinuity right down to the finer fractions." Bacon, F., OFB XI, 391.

²¹ OFB XI provides many instances in which appetites and their motions are treated on par with virtues: 'motions and virtues' (371), 'main species of motions and active virtues' (385).

²² For instance, in just three pages there are at least five occurrences of appetites – such as multiplication of spirit, emission of spirit, concentration of matter, etc. – being 'made perceptible' to the sense. For details see Bacon, F., OFB XI, 347-353.

²³ Bacon, F., OFB XI, 347.

²⁴ For more details on the central role of the appetites and their function as active principles in Bacon's ontology, see G. Giglioni, (2010), 149-167.

²⁵ Each body is universally endowed with virtues and latent tendencies: "So a distinction between bodies should be derived from the virtue and power of their spirits no less than from their abundance..." (Bacon, F., *Abecedarium novum naturae*, OFB XIII, 183).

²⁶ See Hutchison, K., *What happened to occult qualities during the Scientific Revolution?*, *Isis* 73/2 (1982): 234.

²⁷ Bacon, F., OFB XI, 105 (emphasis added).

²⁸ Bacon, F., OFB XI, 103-5.

²⁹ Bacon, F., *Historia densi et rari*, OFB XIII, 107 (emphasis mine).

³⁰ For details see Nolan L., (ed.), *Primary and Secondary Qualities. The Historical and Ongoing Debate* (Oxford: Oxford University Press, 2011), especially the essays by Mi-Kyoung Lee, "The distinction between Primary and Secondary Qualities in Ancient Greek Philosophy" (15-41) and R. Pasnau, "Scholastic Qualities, Primary and Secondary" (41-62).

³¹ Locke, J., *An Essay concerning Human Understanding*, ed. K. P. Winkler (abridged) (Indianapolis: Hackett Publishing, 1996), 2.8.10.

³² Hutchison, K., (1982): 233-253.

³³ Hutchison, K., (1982): 233; 243-253.

³⁴ Bacon, F., OFB XI, 105 (emphasis mine).

³⁵ Ramos, A. P., *Francis Bacon's Idea of Science and the Maker's Knowledge Tradition* (Oxford: Oxford University Press, 1988), 92.

³⁶ Ramos, A. P., (1988), 92.

³⁷ Ramos, A. P., (1988), 94. On Bacon's primary-secondary qualities distinction, see the short discussion in Jardine, L., *Francis Bacon: Discovery and the Art of Discourse* (Cambridge: Cambridge University Press, 1974), 112-3.

³⁸ Ramos, A. P., (1988), 95.

³⁹ Tangible matter is first of all inert. It is also cold and dense and shares in the property of heaviness. The nature of pneumatic matter, which is more subtle than the tangible one, is often designated by Bacon with the term 'spirit.' Nonetheless, pneumatics or spirits have a corporeal nature, though one which is weightless. Interestingly enough, spirits are extended in space, although invisible. As Rees puts it, following Bacon, a spirit is nothing "but a rarefied

body, akin to air, though greatly differing from it.” See for details, Rees, G., *Matter Theory: A Unifying Factor in Bacon's Natural Philosophy*, *Ambix* 24/2 (1977): 110-125.

⁴⁰ “Now things escape the sense either because of the distance at which the object stands... or because the object is incapable of making an impression on the sense; or because the size of the object will not let the impression be carried to the sense...” Bacon, F., OFB XI, 347.

⁴¹ Bacon, F., OFB XI, 347.

⁴² For details about the weatherglass see Borelli, A., “The Weatherglass and its Observers in the Early Seventeenth Century”, in *Philosophies of Technology: Francis Bacon and his Contemporaries*, eds. C. Zittel et al. (Leiden, Boston: Brill, 2008), 67-130.

⁴³ Bacon, F., *Historia densi et rari*, OFB XIII, 107.

⁴⁴ Apud. Rees, G., (1977): 111-112.

⁴⁵ See note 20 above for the whole list of structural motions in Bacon’s theory of matter.

⁴⁶ Bacon, F., *Abecedarium nouum naturae*, OFB XIII, 167.

⁴⁷ Bacon, F., OFB XI, 233.

⁴⁸ Bacon, F., OFB XI, 399-401.

⁴⁹ Categorical properties are the primary properties mentioned above, which in modern language form what is called the “categorical basis of the power”, that is, those properties which are “permanent and exists clearly before the substance exercises its power”. See for details Kistler, M., and Gnassounou, B., (eds.), *Dispositions and Causal Powers*, (Adelshot: Ashgate, 2007), 14-15.

⁵⁰ See for details Kistler, M., and Gnassounou, B., (2007), 15-16.

⁵¹ According to the Scholastics, dispositions could have been interpreted as (quasi) substantial attributes or ‘real accidents’, that is, properties that have an independent ontological status from the substantial form that they had to depend on. The atomists rejected this type of reification of dispositions claiming that these properties have an obscure status of being both independent (*res*) and dependent upon substances. See for details Kistler, M., and Gnassounou, B., (2007), 11-13. For Bacon’s rejection of traditional philosophy and Scholastics’ substantial forms, see Rossi, P., (1968), 42-48 and Ramos, A.P., (1988), 1-73.

⁵² Weeks, S., *Francis Bacon and the Art-Nature Distinction*, *Ambix* 54 (2007): 108.

⁵³ Bacon, F., *Abecedarium nouum naturae*, OFB XIII, 191.

⁵⁴ Bacon, F., *Abecedarium nouum naturae*, OFB XIII, 109-110.

⁵⁵ Bacon, F., *De principijs atque originibus*, OFB VI, 200.

⁵⁶ See the chapter *Bacon's theory of matter*, above.

⁵⁷ Weeks, S., (2007): 123, footnote 133.

⁵⁸ S. Weeks is one of the Baconian scholars who draw attention to this important role played by cosmogony in Bacon’s philosophy. See for details Weeks, S., (2007): 106-112.