Homberg's Chemistry: a Certain Truth into a Disputable Physics[1]

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In 1702, Homberg began publication of his *Essays of Chemistry*, which were supposed to be the first part of a whole book on chemistry. He began the first essay by giving the definition of chemistry as: "Chemistry is the art of reducing bodies into their principles by the fire and of composing new bodies by blending different matters".[2]

Such a definition may appear paradoxical: why did Homberg give, three years after the renewal of the Académie Royale des Sciences, such a classical definition of chemistry?[3] Indeed, he clearly recalled the Paracelsian spagyry, the art to join and separate. In fact, this definition was more important that it would have been, if it were only a way to recall a tradition. This definition has to be understood in the context of the end of the 17th century and the debates about the rules of scientific knowledge. This definition was a way for Homberg to achieve a double task:

a) He intended to give to chemistry a theoretical background: it was not only an experimental physics (role to which Fontenelle for example seemed to confine it), in order to make of the mechanical principles (motion, figure, size of particles) but the *explanans* of real scientific explanations;

b) Homberg inverted the hierarchy between mechanics and chemistry: the latter only was certain, whereas the former was hypothetical, or, to use his own words, was not unquestionable.

This double task was performed by a subtle use of the principles, which articulates the mechanical principles of physics and the chemical principles. Homberg wanted to show that chemistry was the certain part of a disputable physics: it will be shown that there was no paradox here.

First, it is necessary to examine Homberg's commentary on his definition of chemistry. This commentary does not mainly bear on the notion of chemistry as an art,

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even if it was important as will be shown, but it bears on the notion of principle. Homberg distinguished two sorts of principles. In the most general sense, the principles of chemistry were its foundations: these principles were the arrangement, motion and size of the "first matters" –it is important to note the plural here: it is not question of the universal matter of the Cartesian mechanism. However Homberg refused to discuss these principles: it would be, he says, "too long", because, "we do not have success in establishing nothing which is not incontestable". The principles of the second sort are the chemical principles: they are "more material and sensible", and they set up the certain knowledge which was sought.

At the end of this quick commentary, the inversion was achieved: physics was declared to be only hypothetical (as if everybody would easily agree), and its explanations will be, only likely. This did not mean that physics was false. This would be a contradiction: if physics was false, it would not be possible to say that a part of it was true. Moreover, Homberg recurrently declares that he is a physicist. But each time he says this in a peculiar context, it was a way to underline a way of reasoning:

"This reasoning, even if it seems likely, does not prove anything, unless it is sustained by well observed facts, because in physics we are so little clear-sighted that we are often mistaken, even when we believe to possess good facts and reasons".[4]

To stress the limits of physics was a way to call on new or at least other experiments – which was the task of chemistry. This means that, in short, it was not possible to be a good physicist without being a good chemist. But if chemistry was an art, as Homberg recalled in his definition, then one has to admit that it was not reducible to physics. It was not only that experiments were necessary. In this case the possibility that chemistry would be only an experimental physics would remain. In fact, chemistry had its own principles because it was an art of experimenting: its principles have to allow it to discover and expound facts:

"As chemical physics, which consists only in experiments and exposition of facts seeks only certain truth, it has established this second sort of principles, more material and sensible, by men of which it pretends to explain easily and in its way it own operations and to know thereby more distinctively the bodies it examines in its analyses".[5]

The principles of chemistry have a certainty of which the principles of physics are deprived: they are supposed to derive from experiment. However, what was the point to say that chemistry was a part of physics? Sure, it was not possible to pro-

duce a true chemistry in a false physics; but how was it possible to pretend to have a certain chemistry inside a disputable physics? This is even more paradoxical when we remember that, during the 17th and 18th centuries, to adopt a mechanist position often leads, if not always, to dismiss chemistry as a real science.[6] In order to understand the sense of the reference to the physical principles, it is necessary to examine more closely Homberg's discourse about the chemical principles: Sulphur, Salt and Mercury.

The first principle was Sulphur, or the matter of light: to Homberg, it was the only principle that was really active: "I call Sulphur the active principle, because it acts alone and makes the others act".[7] Let examine how Homberg interpreted this activity:

"To make this opinion intelligible and likely, it is necessary to conceive first that the matter of light is always acting, which seems to me to be a necessary attribute of the active principle. Secondly, that this matter can get by itself into the other principles, change their figure, increase their weight and volume, and join them differently to produce all the mixed bodies which can be sensed, which the property we give to our Sulphur principle".[8]

At a first glance, Homberg interpreted the activity of Sulphur mechanistically. This meant mainly that Sulphur was always moving, and modified the composition of bodies according to its motions. However, this motion seems to have no cause other than itself, at least this question of the origin of this continuous motion was not a chemical question (Homberg just suggests that its cause was divine). However, this motion was only a "necessary property of the active principle":[9] it was not sufficient to understand the activity of Sulphur. Indeed, it did not explain how the Sulphur can join the other principles and so on. To explain that Sulphur can modify the chemical nature of the other principles, Homberg endowed it with a non-mechanical property: the "natural gluten" (which describes this property of gluing). The fact that this position seems to originate in the beginning of the 18th century renders it even more significant: the mechanical principles cannot explain by themselves the activity of Sulphur. Sulphur was a plain chemical principle, and not only a name for a body that can be accounted for in mechanical terms.

The second principle was Salt.[10] As pure Salt, it was invisible, seen only when it was joined with another matter. More than of Salt, one should speak of salts, in the plural, which were only what was knowable with certainty. However, Homberg supposed, from 1708, that pure Salt was a sharp point – and this figure accounted for the way in which salts act. However, the Salts were differentiated

from each other by the sulphur, which was always joined to them. Sulphur makes of an imperceptible point, an empirical chemical salt, which can be subjected to experiments:"The difference between salts consists only in the different sulphurs which accompany them".[11] Moreover, Sulphur was what makes the salts act:

"All the actions of acids on alkalis and alike are only performed because they are pushed the one into the other by the matter of light, of which I have proved elsewhere that it was always moving, that it hits the solid parts of all bodies, that is to say that it pushes them continually".[12]

Sulphur moves the salts, and their motion was determined by the association between the pure Salt and the peculiar sulphur that was joined with it. Sulphur makes of Salt a chemical object, of which Homberg gave a physical account.

The last principle with which Homberg dealt was Mercury. It was said to be a principle only because of the failure of its chemical analysis: the principle was confused with common quicksilver. However, to Homberg, it was a principle of metals. The memoirs he devoted to Quicksilver illustrated this position, by proving the composition of gold as Sulphur and Quicksilver. Basically, Homberg pretended to have produced gold by introducing light (that was to say Sulphur) into a prepared quicksilver.[13] What is of interest was the way in which Homberg explained his experiment. The action of the matter of light consists in changing the nature of the quicksilver: it modifies its form, or its figure, or its figure, weight, volume.[14] Once again, the explanation was mechanistic: the matter of light destroyed the spherical particles of quicksilver, so that it became a new metal. Nevertheless, Homberg thought that his explanation was true:

"All what we have said of the destruction of gold and silver being true, that is to say that the important quantity of solar rays coming from the burning glass drove out the matter of light which stopped before in the little channels of the balls of quicksilver".[15]

This reasoning or analysis was a model to understand the production of all sulphurous matters. Homberg constantly called on mechanism. In addition, one may ask, what does remain to chemistry as a part of physics? If chemistry was a part of physics, it was to be understood that it was a sort, or a kind, of physics. The specific difference is well illustrated by the "natural gluten" of the Sulphur, as a non-mechanic property, and certainly, "natural" also means essential. With this property, Sulphur links physics and chemistry. This was shown by Homberg's reflections on Salt and Quicksilver: chemistry deals with facts, physics tries to account for them, when no chemical discourse was possible, it was not possible to explain chemically the principles of chemistry, even if the physical explanation

was not absolutely complete. At least, all this means that the chemical bodies were subject to the physical laws.

It is now possible to understand the signification of Homberg's so called mechanism: why did he call on mechanism and the principle of physics, and declare at the same time that they were at best, likely only? First, it is necessary to note that Homberg was not a mechanist, as the Cartesians had been; and he was neither a chemist who tried to elaborate a solution of "compromise", as Marco Beretta put it,[16] between chemistry and mechanism. However, the mechanical principles gave an interpretive scheme for chemical phenomena, or at least for some of them. This scheme was probable; as already said, this does not mean that it is false. Such principles may be true, but there is no certainty about any mechanical explanation. That is why they do not constitute a veritable science. However, the question remains: why did Homberg not content himself with the certainty of facts and exposition of facts?

A first evident answer, is that he needed explanations to produce a science. Moreover, dealing with principles lead him to a logical problem: it was not possible to explain chemical principles with chemical principles, of course. It is a signification of the mechanical scheme used by Homberg. More generally, it is to be noted that if experiments provide certainty, they are not intelligible immediately or by themselves, that to say that facts are to be explained. The problem is that the action of the principles cannot be observed directly: we can only perceive the effects of their action. This entails that, if the experiment is certain, the detail of what happens during the operation is not that clear (it could be said, it is completely unclear, after all, nobody is in the retort to see what happens here). Using mechanical principles makes of this unperceivable detail of experiment an object of thought, mechanism gives a rigorous conceptual representation of the operation. The experimented fact receives a kind of additional authentication, if it can be explained by the mechanical principles, then it is compatible with the general laws of physics. This gives reasons to think that, for example, it is not an experimental illusion. Finally, it is not impossible to produce gold, even if it seems to be quite incredible. To say it in another way, the physical or mechanical explanation does not account for the fact itself, but it accounts for its possibility. To do that, a probable, or a likely explanation is enough. However, it does not entail that the mechanical principle can explain the chemical fact. In this sense, Homberg is not a mechanist, and in spite of appearances, his chemistry was not mechanical, because it cannot be reduced to physics:

a) Chemistry is certain, whereas the physical explanations are probable: they do not produce knowledge. In addition, if physical explanations bear on the pos-

sibility of facts, it means that it is chemistry, which decides of the way of using these mechanical principles.

b) The mechanical interpretive scheme concerns mainly the principles. However, it does not mean that chemistry is not a causal knowledge, just as physics is: the presence of a principle in a mixed body is an explanation of the properties of that body.

Using the mechanical principle gives an additional intelligibility. Nevertheless, it does not add any certainty. That is why, according to Homberg, chemistry was the real science of bodies.

Notes

[1] This paper is a shortened version of: "La chimie de Homberg: une chimie certaine dans une physique contestable", *Early Science and Medicine*, 10, 1 (2005), 65-90. The rewriting is mine (Luc Peterschmitt).

[2] "J'appelle Chimie l'art de reduire les corps composez en leurs principes par le moyen du feu, & de composez des nouveaux corps dans le feu par le mélange de differentes matieres" ("Essays de Chimie", *Mémoires de l'Académie royale des Sciences* (1702) : 33-52, on 33 – all translations from French into English are mine).

[3] F.L. Holmes rightly insisted on the importance of this definition: Homberg gives the general conceptual framework in which other chemists as Geoffroy or Louis Lémery will work – see. F. L. Holmes, "The Communal Context for Etienne-François Geoffroy's 'Table des rapports'", *Science in Context*, 9, 3 (1996), 289-311, on 292.

[4] "Ce raisonnement, quoiqu'il paraisse vraisemblable, ne prouve cependant rien, à moins qu'il ne soit soûtenu par des faits bien observés, car en matière de Physique nous sommes si peu clairvoyans, que souvent nous nous trompons même quand nous croyons être bien munis de faits & de raisons" ("Observations sur l'Acide qui se trouve dans le Sang & dans les autres parties des Animaux", *Mémoires de l'Académie royale des Sciences* (1712): 8-15 on 10).

[5] "Comme la Physique Chimique, qui ne consiste qu'en experience & exposition de faits, ne cherche que la verité certaine, elle a établi cette seconde sorte de principes plus materiels & plus sensibles, par le moyen desquels elle prétend expliquer aisément & à sa maniere ses propres operations, & connoître parlà plus distinctement les corps qu'elle examine par ses analyses" ("Essays de Chimie", 33)

[6] See Bernard Joly, *Descartes et la chimie* (forthcoming), and Luc Peterschmitt, "The 'Cartesians' and Chemistry: Cordemoy, Rohault, Régis", in, *Chymists and Chymistry, Studies in the History of Alchemy and Early Modern Chemistry*, ed. Lawrence Principe (Philadelphia: Science History Publications/Chemical Heritage Foundation, 2007): 193-202.

[7] "Nous appelons le souffre, principe actif, parcequ'il agit seul & qu'il fait agir les autres. » (" Essays de chimie", 34).

[8] "Pour rendre cette opinion intelligible & vrai semblable, il faut que je fasse concevoir premierement que la matiere de la lumière est toûjours agissante, ce qui me paroît un attribut inséparable du principe actif. En second lieu que cette matiere se peut introduire dans les autres principes; les changer de figure, les augmenter de poids & de volume, & les joindre differemment ensemble pour en produire tous les mixtes qui nous tombent sous les sens, ce qui est le caractere

que nous donnons à notre Souphre principe" ("Suite des Essais de chimie, Article Troisième, Du Soufre principe", *Mémoires de l'Académie royale des Sciences* (1705) : 88-99 on 88-89).

[9] "Un attribut nécessaire du principe actif" ("Suite des Essais de chimie, Article Troisième, Du Soufre principe", 92).

[10] About salt in general in the chemistry of the 17th and 18th centuries, see R. Franckowiak, *Le développement des théories du sel dans la chimie française de la fin du XVIe à celle du XVIIIe siècle*, Thèse de doctorat, Université Lille 3-Charles De Gaulle, 2002, especially pp. 329-375.

[11] "Les sels reçoivent avec beaucoup d'avidité les souffres, mais c'est sans les changer de nature, en quoy leur transposition est differente de celle dont nous venons de parler, c'est-à-dire qu'un souffre animal, par exemple, transplanté dans une matiere saline n'est pas changé en un souffre bitumeux ou autre, il demeure le même, mais il caracterise le sel auquel il se joint; & comme les souffres volatils changent aisément de nature, si par quelque accident le souffre, par exemple, qui aura caractérisé le sel commun, se peut changer en celui qui caracterise le salpetre, le sel commun deviendra salpetre, & ainsi des autres; ensorte que la difference des sels ne consiste que dans les differens souffres qui les accompagnent" ("Suite de l'article trois des Essais de chimie", *Mémoires de l'Académie royale des Sciences* (1706): 260-272 on 270).

[12] "Que toutes les actions des acides sur les alcalis & semblables, ne se font que parce qu'ils sont poussez les uns dans les autres par la matiere de la lumiere, que j'ai prouvé ailleurs être toûjours en mouvement, heurter contre les parties solides de tous les corps, c'est-à-dire les pousser continuellement" ("Observations touchant l'effet de certains Acides sur les Alcalis volatils", *Mémoires de l'Académie royale des Sciences* (1709): 354-363 on 357).

[13] For a detailed account, see. L. Principe, "Wilhelm Homberg: Chymical Corpuscularianism and Chrysopoeia in the Early Eighteenth Century", in *Late Medieval and early modern Corpuscular Matter Theories*, ed. C. Lüthy, J.E. Murdoch, William.R. Newman (Leiden: Brill, 2001), 535-556, and his "Wilhelm Homberg et la chimie de la lumière", *Methodos*, 8, (2008), *http://methodos.revues.org/document1223.html*.

[14] "Premierement qu'il s'est introduit quelque chose dans ce mercure, puisqu'il est devenu plus pesant: secondement que ce qui s'y est introduit *l'a changé de nature*, puisqu'il ne coule plus, & qu'il devient en partie malléable: troisièmement que ce qui s'y est introduit s'unit parfaitement au mercure; […] par la precedente operation j'aye prouvé que la matière de la lumière qui s'est engagée dans le mercure y est restée inséparablement, même au grand feu, & qu'elle a *changé la forme* du mercure en celle du métail malléable et ductile; […] Estant donc persuadé que la matiere de la lumière est la seule qui peut penetrer très-librement tous les corps poreux, & qui est la seule qui agit toûjours, comme nous l'avons montré dans la première partie de cet article; & que cette matiere est capable de s'introduire dans tous les autres corps, de s'y arrêter & de les changer par-là de figure, de poids & de volume, nous avons crû que nulle autre matiere ne pouvoit être nôtre Souphre principe & nôtre seul principe actif, que la matière de la lumière" ("Suite des Essais de Chimie. Article troisième. Du Souphre principe", respectively 93, 95, 96 – my emphasis).

[15] "Tout ce que nous venons de dire de la destruction de l'or et de l'argent étant vrai, c'est-à-dire, que la grande quantité de raïons du soleil qui partent du verre ardant chassent la matière de la lumière qui s'étoit arrêtée dans les petits pertuis des boules du Mercure" ("Suite des Essais de Chimie. Art. IV. du Mercure", *Mémoires de l'Académie royale des Sciences* (1709): 106-117 on 109).

[16] M. Beretta, *The Enlightment of Matter, the Definition of Chemistry from Agricola to Lavoisier*, Canton: Science History Publications, 1993, 122.