THE 1987 DEXTER ADDRESS

Quantification and Medical Motivation: Factors in the Interpretation of Early Modern Chemistry

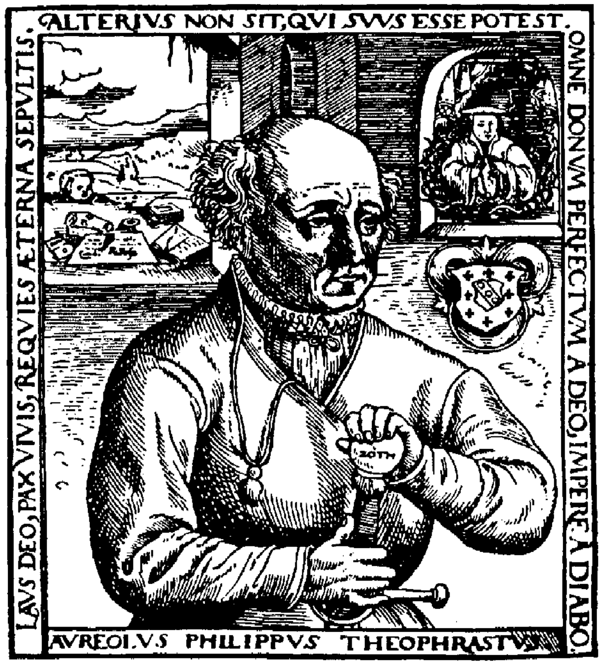
When the historian of science seeks a conscious "revolution" in the science of the sixteenth century he normally turns to Copernicus and to the physical problems resulting from a sun-centered cosmology. In solving these the power of mathematics becomes evident in the progression from Copernicus to Galileo to Newton. But the historian of chemistry should be equally interested in Paracelsus, a younger contemporary of Copernicus. This Swiss-German firebrand called not only for new observations in nature, but also for chemistry to be the key to a new understanding of nature and man.

If mathematics played such a significant role in astronomy and physics, what was its place in Renaissance chemistry? To be sure, quantification had always been important to the chemist. Quantities had to be weighed in the alchemists' laboratories while assays of ores and practical pharmaceutical recipes all involved the use of the balance. These men - and the Paracelsians also - frequently cited Scriptural authority stating that God had created "all things in number, weight and measure." There seemed little doubt that nature should be investigated mathematically.

Here the real question involved the proper use of mathematics. Laboratory weights and measures were clearly appropriate for the chemist and they seemed to be upheld by Scriptural authority. But Renaissance savants thought also of a higher form of mathematics related to universal harmonies and natural magic. Paracelsus affirmed that true mathematics is magic which may, in turn, be equated with the study of nature. The godly magus is a mathematician who may concentrate in himself celestial virtues which are the hidden powers of nature. He may then use these powers to work wonders and learn of his Creator.

The chemists' call for quantification may best be seen in the work of Jean Baptiste van Helmont, a contemporary of Galileo. He is best known for his willow tree experiment in which he took a weighed sapling, planted it in a weighed amount of earth, watered it for five years and then reweighed it. There was an increased weight of 164 pounds which he attributed to water since the weight of earth remained the same. Here and elsewhere in his writings we find an author who regularly used quantification in his laboratory work.

But van Helmont considered this practical quantification simply to be normal observation rather than the use of mathematics in the interpretation of phenomena. The latter, he thought, was the ancient logical approach to nature which was akin to the deductive process of the geometrician. The Aristotelians and Galenists sought to apply such reasoning to medicine and they had failed in their attempt. For van



Paracelsus

Helmont, rational, mathematically-inspired investigations may aid us in the study of physics, but not in attaining the chief goal of natural philosophy - medicine - for to "understand and favour these things from the spring or first cause is granted to none without the special favour of Christ the Lord."

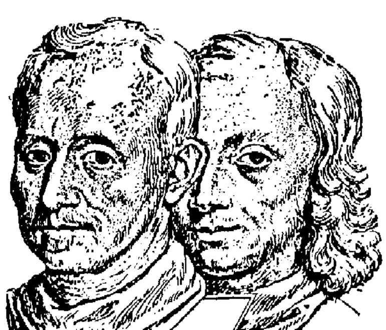
Rejecting the mathematical investigation of local motion, van Helmont specifically attacked the use of mathematical abstraction as a proper tool for the scholar. Motion is due to a divine *blas*, an internal force which causes the beating of the heart and other motion without contact or the need of an immoveable mover, a concept basic to the Thomist interpretation of Aristotelian physics. Because of this van Helmont concluded that the Aristotelian descriptive interpretation of nature "is a Paganish Doctrine drawn from Science Mathematical, which necessitates the first Mover to a perpetual unmoveablenesse of himself, that without ceasing he may move all things."

Paracelsus, van Helmont and other Chemical Philosophers of the period were all influenced by their alchemical heritage. True, they believed in the value of mathematics and quantification, but they did not agree on a single method. Paracelsus had emphasized the importance of a mathematical interpretation that would be judged mystical and valueless by modern standards. Van Helmont applied weights and measures to chemical investigation in a significant manner, but he firmly rejected the use of mathematical abstraction as a proper method for the understanding of natural phenomena. As historians of chemistry we may conclude that the use of mathematics and the type of quantification practiced by pre-Boylean chemists was frequently mixed with mysticism and that it ignored the mathematical sophistication employed by contemporary physicists and astronomers.

And yet, the followers of Paracelsus were the most determined of those who sought to overturn the establishment science and medicine of the sixteenth and early seventeenth centuries. They - and thus chemistry - must therefore play a major role in any assessment of the Scientific Revolution. But if the growth of mathematical abstraction and quantification will not serve chemistry as it does physics, how should we best approach the chemistry of the early modern period? I think that the answer is to be found in its relation to medicine.

It is true that the accumulated metallurgical knowledge of past centuries was to play a role in the development of science, but for the Renaissance chemist, chemistry was primarily a medical subject. The Galenists who dominated the medical schools stubbornly tried to halt the growing interest first in chemically prepared medicines and then in chemical interpretations of physiological processes. Bitter debates occurred throughout Europe as Galenists attempted to maintain their ascendency. And yet, the first appointment of a Professor of Chemical Medicine, Johann Hartmann at Marburg, was made as early as 1609. Throughout the seventeenth century more and more Chairs of Chemistry were established - almost always through medical faculties - so that by 1700 there were few medical schools in Europe lacking instruction in chemistry. To accompany these new courses the instructors prepared textbooks of chemistry that centered on medical preparations. These vary from works strongly tinged with Paracelsian mysticism to austere texts practically devoid of theory that confine themselves only to preparations and their use.

I would not argue that we should scrap our understanding of a Chemical Revolution associated with the work of Lavoisier and his colleagues. However, I do believe that if we are to assign chemistry to its proper place in the Scientific Revolution of the sixteenth and seventeenth centuries, we must begin to think of a two-phase chemical revolution over a much longer time period. The first part involves Paracelsus and his followers who made chemistry the key to medicine. Their work resulted in a major debate with the educational establishment - and eventually in the academic acceptance of chemistry in the course of the seventeenth century. It was this medical background that was to be the basis of Stahl's phlogiston theory and the new debates of the eighteenth century that were to culminate in the work of Lavoisier. The vitalist medicine of Montpellier that developed in the course of that century was also grounded in Paracelso-Helmontian thought and this is a connection that historians of chemistry will have to examine in greater detail in the future. Furthermore, we are confronted with the fact that the eighteenth century saw the publication of a vast number of alchemical and Paracelsian works which to date have not been studied in detail. They must be in the future if we are to understand the connection between these traditions and the work of Mesmer or the late eighteenth-century interest in Rosicrucian and Masonic thought.



Van Helmont and son

In short, the Scientific Revolution has been interpreted primarily in terms of physics and astronomy - the road from Copernicus to Newton. The basis of this viewpoint has been the impact of quantification and mathematical abstraction on the sciences. This, however, is but one factor of many. It is certainly appropriate for physics, but it is inappropriate for other fields. It is certainly inappropriate for chemistry where the relationship to medicine is more significant and where a consistent appreciation of quantification became a major concern only in the course of the eighteenth century. We should then be concerned with two chemical strands, the first a medically oriented chemistry in combat early with Galenic medicine. Its practitioners became entrenched in the medical faculties of Europe in the course of the seventeenth century. The second strand is later and more familiar, the chain of discoveries that led to the abandonment of phlogiston chemistry in the late eighteenth century. Here indeed quantification played a major role. Both strands are essential for our understanding of the development not only of chemistry, but of the Scientific Revolution as a whole.

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