Science and Its Public Perception:
The Principle of Least Action in Eighteenth-Century Europe

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1. Introduction

In a newsletter dated February 24th 1753, the Parisian journalist Elie Fréron reported a controversy which "makes still much noise in Europe." It was a controversy between two scholars over the principle of least action, a principle which would come to play an important role in contemporary physics. Since Fréron did not have enough materials for his article, he made inquiries to "a man of Letters" who was familiar with the controversy, and reprinted the latter's response in his news article (Fréron 1753, p. 198).

This newsletter is interesting because it reflects the relationship between science and the public in eighteenth-century Europe. Contrary to the present day where scientific knowledge is almost out of reach for ordinary people, science in eighteenth-century Europe was incorporated into what is called the Republic of Letters, in which even mathematical subjects such as the principle of least action were actively discussed by "men of Letters." However, close examination will reveal that there was already at that time a great gap between science and the public, particularly in the case of mathematical sciences.

In what follows, I will attempt to consider this gap, using the principle of least action as an example. After giving an overview of the principle and the subsequent dispute called "König Affair" (sec. 2), I will show how this scientific dispute became a "literary quarrel," a popular topic of gossip (sec. 3). We will see here that mathematics operated as a barrier between science and the public; however, I will also show that it could work in a similar way even within the scientific community (sec. 4). In short, there were walls of mathematics in the Republic of Letters.

2. The Principle of Least Action and the "König Affair"

The principle of least action was proposed in 1744 by a Frenchman, Pierre-Louis Moreau de Maupertuis (1698-1759). As a unification of the laws of light (rectilinear

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propagation, the law of reflection, and the law of refraction), he declared that the path of light was the one "thorough which the quantity of action is the least" (Maupertuis 1744, p. 278). This is commonly regarded as the first (but ambiguous) statement of the principle of least action. In the same year, a prominent Swiss mathematician, Leonhard Euler (1707-1783), published *A Method for Finding Curved Lines Enjoying Properties of Maximum or Minimum*, exploring another form of the principle in its second appendix. Maupertuis called it "a beautiful application" of his original principle, and Fréron's correspondent repeated this expression (Maupertuis 1746, p. 282; Fréron 1753, p. 199); we will come back to this point later.

Subsequently Maupertuis published his second paper on the principle of least action. This time, he treated the laws of collision and a few problems of equilibrium using his general principle: "When some change happens in Nature, the quantity of action, which is necessary for this change, is the smallest that is possible" (Maupertuis 1746, p. 298). Although, from a modern point of view, the mathematics of his argument is untenable, Maupertuis was very excited to be able to propose a universal principle from which various laws of nature derived. He even believed that this universality showed the power and wisdom of God, therefore proving his Existence.

Given Maupertuis's feelings of accomplishment, the reasons why he overacted to a 1751 article by Johann Samuel König (1712-1757) may be understandable. In this paper, König cited an unpublished letter attributed to the famous philosopher Gottfried Wilhelm von Leibniz (1646-1716), which says that "I remarked that in modifications of movements [action] becomes ordinarily a Maximum, or a Minimum" (König 1751, p. 324). Perhaps König did not intend to attack Maupertuis's priority, but the latter feared that it would nevertheless undermine his glorious achievement. In addition, Maupertuis, who was then president of the Berlin Academy of Sciences, had elected König as a foreign member of the Academy. Therefore, the president may have felt as if he had been betrayed by a subordinate.

President Maupertuis pushed the Academy to investigate the authenticity of that letter, leading to the Academy's demand that König present the original document. It turned out however, that König had nothing but its copy. Following the subsequent search for the original letter which ended up in vain, the Academy concluded in April 1752 "that [König's] cause is the worst and that this fragment was forged" (Euler 1750, p. 72). König protested this decision by sending back his membership diploma, following which many critical pamphlets appeared from both König's and Maupertuis's side. This is the so-called "König Affair" that Fréron's correspondent explained to the public.

3. A Scientific Dispute Becomes a Literary Quarrel

Although originally an academic matter, the controversy soon spread beyond the Academy. On the one hand, König published his literal *Appeal to the Public* in protest at Academy's decision; on the other, Euler, then director of mathematics of the Berlin Academy, defended the president vigorously, publishing counterarguments against König. What is especially remarkable is the fact that Euler's two articles which criticize König were published as a book for the public, prior to its inclusion in the official journal of the Academy. Moreover, while the journal (*Mémoires*) was published only in French, Euler's book was bilingual (original French text with Latin translation) so that more people could read it. As Mary Terrall observes, "the academicians wanted to reach a public beyond the readers of the *Mémoires* of the Berlin Academy" (Terrall 2002, pp. 300-1).

In order to understand this situation, we must keep in mind that European eighteenth-century science was incorporated into the Republic of Letters, an imaginary community to which the public felt connected. In principle anyone could be a citizen of this Republic, as long as he/she was literate; regardless of nationality, members were united by a great number of correspondents, books and journals. Interestingly, these published matters covered not only literary or social subjects but also disputes on scientific matters. As we have seen in the case of the principle of least action, such disputes sometimes resulted in serious breakups between scholars; however, the "König Affair" did not come to an end here.

Fréron's article includes a list of publications concerned with the dispute, in which we find *Diatribe of Dr. Akakia*, a satire which attacked on Maupertuis's works and personality. Surprisingly, the author was Voltaire (1694-1778), the most influential writer of this period and the last person expected to join in the mathematical controversy. Nevertheless, it was this work which, by ridiculing Maupertuis as a tyrant who had forced academicians to make an absurd decision, brought the "König Affair" into the public sphere. It soon became a spectacle in both the literal and figurative sense; on December 24th, copies of *Diatribe* were burned in a public square on orders of the King of Prussia. It was a "spectacle which one had never seen in Berlin in the past" (Fréron 1753, p. 210). This is how the scientific dispute became a "literary quarrel," a popular topic of gossip in the Republic of Letters.

This being the case, to what extent did Voltaire understand the mathematical aspects of the problem? The answer is probably very little. Judging from the fact that he calls the principle of least action an "I-do-not-know mathematical nonsense" (Voltaire

1784, p. 39), he seems to have neither an idea of nor an interest in it. Actually, the mathematics which Maupertuis used in his articles was (at an elementary level) differential calculus, a most-advanced technique in that period and one which required considerable self-study. Therefore it can be presumed that, even if the public widely discussed the "König Affair," it was without much understanding about what the principle of least action actually was. For example, in the compendium *Literal Quarrels*, we find a story about "Mr. Voltaire, and Mr. Maupertuis" which lacks substantial explanations of the principle; nevertheless, its author could declare that "it is of service to the public to give him a faithful history [of the quarrel]" (Irail 1761, p. 72).

4. A Wall of Mathematics between Maupertuis and Euler

Through Maupertuis and Voltaire, we have just seen how mathematics operated as a barrier to public understanding of sciences. However, even within the scientific community, mathematics could work in a similar way. This is connected to the reasons why Euler defended Maupertuis so vigorously. It is commonly said that Euler favored Maupertuis's metaphysical arguments or that the director of mathematics made concessions to the president. Yet these explanations do not seem sufficient, especially because Euler reached his own principle (published in 1744) independently of, and earlier than, Maupertuis; Euler communicated the result to his friend Daniel Bernoulli (1700-1782) in 1743. Therefore, Euler's work could not be an "application" of Maupertuis's.

The key to this paradox is the "law of rest," a principle which Maupertuis had stated at an earlier time. It concerns a rest, or equilibrium of bodies subjected to forces. Although Maupertuis's original version was limited, Euler generalized it in 1745, as soon as he read Maupertuis's article. In subsequent studies, Euler found that his 1744 result (alleged "application") could be derived from the generalized "law of rest." (From a modern point of view, Euler's argument is incorrect.) Therefore, Euler's version of the principle of least action is more an "application" of the "law of rest" than that of Maupertuis's 1744 paper.

In the middle of the "König Affair" Euler published an article, in which he reveals the "beautiful harmony" between the "law of rest" and the principle of least action (Euler 1751, p. 152). It was on this basis that Euler insisted the importance of the principle and Maupertuis's priority. Although Euler emphasizes its "universality," similar to Maupertuis, his meaning is quite different: the principle of least action is important because it unifies the laws of equilibrium and motion, and it is this

combination that "declares the most universal Law of nature" (Euler 1753, p. 193).

It is not clear to what extent Euler's argument was understood at that time. His mathematics was still more advanced than Maupertuis's, and therefore it must have been completely out of public reach. Even Maupertuis seems to have been incapable of keeping up with him. Euler had explained to Maupertuis again and again (in his letters of 1748) why the "law of rest" was important, but it was only after the appearance (1753) of Euler's "harmony" paper that Maupertuis referred to his own "law of rest." Even then, he appears to repeat Euler's words only superficially; at least, nowhere does Maupertuis give an explanation of how his two principles are conformable to each other.

5. Conclusion

European eighteenth-century science was incorporated into the Republic of Letters, in which the public or "men of Letters" discussed scientific matters. As long as the principle of least action was concerned, however, it was not the original academic matter concerning the universal principle of nature that the public was interested in, but the dispute over Maupertuis's priority or gossip about the "tyranny" of the Academy. In this sense, we can conclude that there was a great distance between science and the public. While the principle of least action was a matter of science, the "König Affair" was more related to its public perception.

As we have seen above, there were walls of mathematics in the Republic of Letters: Voltaire could not understand Maupertuis, and Maupertuis could not understand Euler. This is why Fréron's correspondent assured the public that he could explain the dispute "without frightening you by algebraic formulas" (Fréron 1753, p. 198). Such walls have always existed and will continue to be there; one has to translate technical arguments into a common language. At the same time, however, the "König Affair" shows that such a translation process might change the nature of problem itself, as in Voltaire's works. In short, the Republic of Letters is a productive site through which we can consider the relationship between science and the public.

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