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The Influence of Mathematics on the Philosophy of Spinoza*

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1. *Introduction: Spinoza's Life.* In 1632 Baruch or Benedict de Spinoza was born in Amsterdam of Jewish parents. Benedict's father was a well-to-do merchant who sent him to the school of the rabbis where he received thorough training in Hebrew language, literature, and philosophy. But Benedict's thirst for knowledge was not satisfied. He studied Latin authors, what there was of physical science, and the philosophy of Descartes. In 1656 Spinoza was excommunicated by the Court of the Rabbis and disowned by his family. Cast upon his own resources, he took up the trade of grinding lenses. In the year that followed, many careers, including teaching, were opened to him, but he preferred to spend his time in the pursuit of knowledge. He corresponded with, and knew personally, some of the most outstanding men of his day; but he never showed any desire for honors. "The dominant trait in his character was his absolute devotion to the search for truth. To this he willingly sacrificed everything, worldly goods, preferment, even health."[1]

In 1677 Spinoza died at the age of forty-four from the effects of tuberculosis. He had contracted the disease more than ten years before from the effects of fine glass inhaled in the polishing of lenses.

The most important work which Spinoza wrote was the *Ethics* (*Ethica More Geometrico Demonstrata*), first published in 1677. It was not published during his lifetime because his contemporaries considered it atheistic. The first of Spinoza's writings to be published

*Read before the Southeastern Section of the Mathematical Association of America, March 29, 1941.

[1] John Wild (ed.), *Spinoza, Selections* (New York: Charles Scribner's Sons, 1930), p. xxi.

was his geometrical treatment of Descartes' philosophy (*R. des Cartes Principiorum Philosophiæ, More Geometrico Demonstrata,* 1663). During his lifetime one other work was published: *The Tractatus Theologico-Politicus* (1670). After his death, the treatise *On the Improvement of the Understanding,* the *Short Treatise on God, Man, and His Well Being,* the *Political Treatise,* and the *Hebrew Grammar* were published.

2. *Spinoza's Mathematics.* The *Scripta Mathematica* list of ten "philosophers who were also mathematicians" includes the name of Spinoza. He wrote nothing on mathematics though he planned to write an exposition of the principles of algebra. He did some work in mathematics in connection with the theory of lens grinding, evidence of which may be seen in his correspondence with mathematicians. Toward the end of his life some of the most significant letters which he wrote were those to Tschirnhaus, a mathematically inclined German. The latter gave Spinoza the most intelligent criticism of his system of philosophy that he had ever received.

Cassius J. Keyser summed up Spinoza's mathematics as follows:

> Was Spinoza a great mathematician? If the term is to designate only such as have made important contributions to so-called "pure" mathematics, the answer is No. But if it be applied also to those who have masterfully applied the mathematical method to no matter what kind of concrete subject-matter, the answer is Yes. For, in the domain of Ethics, the mathematical method became in Spinoza's hands a powerful instrument for both research and exposition.[2]

3. *Spinoza's Philosophy.* Spinoza was one of the group of leading Continental Rationalists. During his lifetime and for some time thereafter he was regarded as an atheist. Since that time the views on him have changed so radically that Novalis called him a "God-intoxicated Jew". In reality Spinoza seems to have been a pantheist, seeing God in everything real and conversely, everything in God. He took the two ultimate realities of Descartes' system of philosophy (mind and matter or thought and extension) and united them into a single reality or substance: namely, God. It will suffice here to say that Spinoza is considered today to be one of the greatest of modern philosophers.

4. *Spinoza's Synthesis of Mathematics and Philosophy.* The aim of this paper is to study the ways in which mathematics was related to the philosophy of Spinoza. Bertrand Russell declared that the influence of mathematics on the philosophy of Spinoza was very obvious.[3] Yet it seems to be worthy of study. In general his point

[2] "Benedict Spinoza," *Scripta Mathematica,* V (January, 1938), 36.

[3] Personal interview, 1939.

of view was similar to that of Descartes, but there are some significant differences. Mathematics was clearly related to the rationalistic method of Spinoza. Thus Martineau declared in relation to Spinoza's statement in the *Cogitato Metaphysica:* "Did men understand the whole order of nature, they would find all things no less necessary than all those of which Mathematics treats":

> Geometry afforded already an encouraging example of this method of discovery: though its figures, as defined, were but abstractions, they so nearly reappeared in concrete objects that their properties were everywhere exemplified, and the system of nature seemed like a vast geometrical construction. Spinoza longs to extend this only secure form of proof throughout the field of knowledge, and apply it no less to the passions of men than to the phenomena of the earth and heavens; and wonders why its use has stopped short with mechanical science, instead of being pressed into the service of Philosophy. The reign of law being universal, the links of necessity in things, with counterpart links of necessity in thought, run through the whole and render all its contents demonstrable. Metaphysics therefore may aspire to stand on the same line with Mathematics.[4]

Let us now briefly consider some of the problems of philosophy with which Spinoza dealt and try to see how mathematics was related to these problems. When mathematics was thought of as an absolute system based on "necessary" axioms, men considered that geometrical form was too inflexible to express the truths of philosophy. Thus John Caird declared:

> ... it is easy to see how Spinoza should regard the science of mathematics as affording the purest type of method, and should endeavour ... to cast his system in geometrical form. In geometry everything is based on the fundamental conception of space or quantity, and the whole content of the science seems to follow by rigid logical necessity from definitions and axioms relating to that conception. Might not the same exactitude, certainty, necessity of sequence be obtained for the truths of philosophy as for the truths of mathematics by following the same method? It was probably some such anticipation that led Spinoza to give to his great work the form which is indicated by its title, "Ethics demonstrated in Geometrical Order," and to set forth his ideas, after the manner of Euclid, in a series of definitions, axioms, and of propositions and corollaries flowing from these by strict logical deduction ... but it may be pointed out here that, from the very nature of the thing, a purely geometrical method is inadequate to the treatment of philosophical truth.[5]

Now that mathematics is thought of as a postulational system of thought, men no longer think it strange that Spinoza expressed philosophical truths in geometrical form.

5. *The Problem of Method.* Spinoza used the synthetic geometrical form of Euclidean geometry in his treatment of Descartes' philoso-

[4] James Martineau, *A Study of Spinoza* (London: Macmillan and Company, 1883), p. 162.

[5] John Caird, *Spinoza* (Philadelphia: J. B. Lippincott Company, 1888), p. 114.

phy, in the appendix to the *Short Treatise*, and in his major work: the *Ethics*. In the geometrical treatment of Descartes philosophy there were twenty-three definitions, thirty-seven axioms, and sixty-one propositions. The *Ethics* contained twenty-six definitions, fifteen axioms, two postulates, and two hundred fifty-nine propositions. Some of Spinoza's predecessors had made casual attempts to use this form. Thus Descartes used the synthetic form of Euclid on one occasion, but he made it clear that he regarded *analysis* as being of more importance than *synthesis*. Spinoza used the form consistently in his discussions of metaphysical matters and mere imitation of his predecessors cannot explain his use of the Euclidean form. Some students of Spinoza have regarded his use of the form as a logical consequence of his mathematical way of looking at things. Thus Pierre Bayle, a seventeenth century commentator declared that Spinoza had a geometrical mind.[6] However, Wolfson, who has recently studied the matter very carefully, states that there is no ground for the assumption that the nature of Spinoza's philosophy demanded that it be written in Euclidean form. He said: "Spinoza's mathematical way of looking at things means only the denial of design in nature and freedom in man, and this need not necessarily be written in the geometrical literary form."[7] In Ludwig Meyer's preface to Spinoza's geometrical treatment of Descartes philosophy:

> ... there is nothing to indicate that the application of the geometrical literary form by Spinoza to Descartes' *Principia Philosophiæ* was the outgrowth of the mathematical method of demonstration employed by Descartes. On the contrary, the indications are that it was considered to be something imposed upon it externally.[8]

According to Wolfson, the reason for Spinoza's choice of the Euclidean form was probably pedagogical:

> Primarily, we may say, the reason for its choice was pedagogical, the clearness and distinctness with which the geometrical form was believed to delineate the main features of an argument and to bring them into high relief. It was used for the same reason that one uses outlines and diagrams.[9]
>
> It is thus always for the benefit of the reader, and because of the clearness with which it is supposed to state an argument, and not because the philosophic system itself demands it, that the geometrical form is made use of.[10]

Spinoza may have used the geometrical form as a reaction against the new literary forms which had been exploited in philosophic writings

[6] *Dictionnaire Historique et Critique*, 1695-1697.

[7] Harry A. Wolfson, *The Philosophy of Spinoza* (Cambridge: Harvard University Press, 1934), I, 45.

[8] *Ibid.*, p. 52.

[9] *Ibid.*, p. 55.

[10] *Ibid.*, p. 56.

since the Renaissance. The Renaissance philosophers had rejected the syllogisms of the mediaeval scholastics, and had consequently lost much in accuracy and precision.

> To return to the old syllogistic method openly and directly would have been a return to scholasticism, for which the world was not yet ready. They therefore returned to it indirectly by adopting the geometrical form. To the philosophers of the seventeenth century the blessed word "mathematics" served as a veneer of respectability for the discredited syllogism.[11]

Finally, the geometrical form of Euclid may have been used by Spinoza merely for the sake of brevity. The *Ethics*, which is only one volume, would have run into many bulky volumes if Spinoza had used the traditional form.

6. *The Problem of Epistemology.* Like Descartes, Spinoza could not be certain that he had any true knowledge until he was certain that God existed. Also like Descartes, he regarded the truths of mathematics as the best criterion of true knowledge. In the treatise *On the Improvement of the Understanding* Spinoza declared:

> . . . . We cannot cast doubt on true ideas by the supposition that there is a deceitful Deity, who leads us astray even in what is most certain. We can only hold such an hypothesis so long as we have no clear and distinct idea—in other words, until we reflect on the knowledge which we have of the first principle of all things, and find that which teaches us that God is not a deceiver, and until we know this with the same certainty as we know from reflecting on the nature of a triangle that its three angles are equal to two right angles. But we if have a knowledge of God equal to that which we have of a triangle, all doubt is removed.[12]

7. *The Problem of Metaphysics.* Spinoza declared that the human race would have been kept in darkness to all eternity with regard to ultimate ends, " . . . if mathematics, which does not deal with ends, but with the essence and properties of forms, had not placed before us another rule of truth."[13]

Spinoza's ontological proof of the existence of God was similar to that of Descartes. Spinoza briefly restated Descartes' argument in Epistola XXI when he said:

> If the nature of God is known to us, then the assertion that God exists follows as necessarily from our own nature as it follows necessarily from the nature of a triangle that its three angles are equal to two right angles.

From Descartes Spinoza derived the method of deducing the properties of God from the concept of necessary existence. Thus he declared in the geometrical treatement of Descartes' philosophy:

[11] *Ibid.*, p. 57.

[12] R. H. M. Elwes (translator) *Philosophy of Benedict Spinoza* (New York: Tudor Publishing Company, 1936), p. 27.

[13] Cf. *Ibid.*, p. 73.

> Indeed, upon this truth alone, namely, that existence belongs to the nature of God, or that the concept of God involves a necessary existence as that of a triangle that the sum of its angles is equal to two right angles, or again that His existence and His essence are eternal truth, depends almost all our knowledge of God's attributes by which we are led to a love of God (or to the highest blessedness).[14]

Martineau summed up Spinoza's use of mathematics in his metaphysics as follows:

> Spinoza, however, relying on a supposed analogy between Geometry and Metaphysics,... attempts to construct a ... science of Substance and its affections, whereby the constitution of the universe shall be deduced from its primary essence,—the All out of the One. How to name that primary essence—"Nature," "Substance", "God,"—might be, and evidently was, a matter of some hesitation with him. But one preconception was involved in his very problem, viz., that of *absolute Necessity* through all the steps of the deduction, like that which, from the essence of triangles, equates its three angles to two right angles.[15]

8. *The Problem of Natural Philosophy.* According to Wolfson, Spinoza used mathematical analogies in natural philosophy to a much greater extent than Descartes had done. In the universe of Descartes there was still room for final causes, for divine will, and for human freedom.

> In Spinoza, on the other hand, the mathematical analogies are used as illustrations of the existence of inexorable laws of necessity throughout nature. Spinoza gives expression to this view when on several occasions he declared that all things follow from the infinite nature of God according to that same necessity by which it follows from the essence of a triangle that its three angles are equal to two right angles, ...[16]

Spinoza distinguished between the *absolutely* infinite and the mathematical infinite, which was what he called merely *infinite of its kind.* He argued that extension, which was the distinguishing characteristic of matter, was infinite. It was not the mere divisibility of extended substance that he understood to be the assumption underlying the arguments against infinity, but rather its divisibility into heterogeneous parts and its composition of those parts, so that extended substance, according to Spinoza, was not considered by his opponents as a continuous quantity. Thus he said in Epistola XII:

> Wherefore those who think that extended substance is made up of parts or of bodies really distinct from one another are talking foolishly, not to say madly. It is as though one should attempt by the mere addition and aggregation of many circles to make up a square, or a triangle, or something else different in its whole essence.

[14] *Principia Philosophiæ Cartesianæ,* I, Prop. V, Scholium.
[15] *Op. Cit.,* pp. 165, 166.
[16] *Op. Cit.,* I, 3.

In regard to Spinoza's treatment of the concept of space, Martineau declared:

> It is this coalescense of thought and thing in the underlying ground of Geometry, that makes it not a mere conceptual but an applicable science. Since space cannot come into thought except as existing out of thought, and its subjective presence is what constitutes objectivity, all the quantitative rules which are reasoned out from its characters are not only functions of its idea, but measures of the world.[17]

9. *The Problem of Practical Philosophy; Ethics and Politics.* Descartes seemed to think that the problems of practical philosophy could not be treated with mathematical exactitude and therefore should not be treated at all. Spinoza, on the other hand, was primarily interested in ethics and tried to deal with ethics in a mathematical way. Thus,in denying human freedom, he declared:

> For the present I wish to revert to those, who would rather abuse or deride human emotions than to understand them. Such persons will doubtless think it strange that I should attempt to treat of human vice and folly geometrically, and should wish to set forth with rigid reasoning those matters which they cry out against as repugnant to reason, frivolous, absurd, and dreadful. However, such is my plan . . . . I shall, therefore, treat of the nature and strength of the emotions according to the same method, as I employed heretofore in my investigations concerning God and the mind. I shall consider human actions and desires in exactly the same manner, as though I were concerned with lines, planes, and solids.[18]

In Part II of the *Ethics* Spinoza listed the reasons which he had for considering his view of human conduct to be good. Among them was the following:

> Inasmuch as it teaches us how we ought to conduct ourselves with respect to the gifts of fortune, or matters which are not in our own power, and do not follow from our nature. For it shows that we should await and endure fortune's smiles or frowns with an equal mind, seeing that all things follow from the eternal decree of God by the same necessity, as it follows from the essence of a triangle, that the three angles are equal to two right angles.[19]

In regard to political philosophy, Spinoza declared in his *Political Treatise:*

> Therefore, on applying my mind to politics, I have resolved to demonstrate by a certain and undoubted course of argument, or to deduce from the very condition of human nature, not what is new and unheard of, but only such things as agree best with practice. And that I might investigate the subject-matter of this science with the same freedom of spirit as we generally use in mathematics,

[17] *Op. Cit.*, p. 164.
[18] Elwes, *op. cit.*, p. 128.
[19] *Ibid.*, p. 125.

I have laboured carefully, not to mock, lament, or execrate, but to understand human actions.[20]

10. *Spinoza's Estimate.* The importance of mathematics in his own philosophy was expressed by Spinoza in a letter to Albert Burgh written toward the end of his life:

> ... you ask ... me, "How I know that my philosophy is the best among all that have ever been taught in the world, or are being taught, or ever will be taught?" a question which I might with much greater right ask you; for I do not presume that I have found the best philosophy, I know that I understand the true philosophy. If you ask in what way I know it, I answer: In the same way as you know that the three angles of a triangle are equal to two right angles: that this is sufficient, will be denied by no one whose brain is sound, ...[21]

[20] A. G. A. Balz (ed.), *Writings on Political Philosophy by Benedict de Spinoza* (New York: D. Appleton-Century Company, 1937), pp. 181, 182.

[21] Elwes, *op. cit.*, p. 423.