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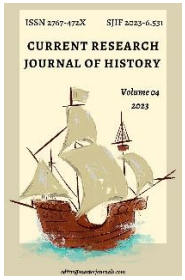

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Research Article

MEDIEVAL ARABIC DEBATES ON KIND-CROSSING

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ABSTRACT

This paper aims to deal with the medieval Arabic commentaries on Aristotle's kind-crossing prohibition introduced in his Posterior Analytics. Islamic Peripatetic philosophers, commenting on the doctrine of allowed and illicit kind-crossing, generally support the ideas of Aristotle. They, like Aristotle, think that all sciences should be kept in their own compartments and autonomously of each other. Since they worry that trying to understand everything as a whole and bring everything together will hinder the development of these compartmentalized sciences. However, it was impossible to talk about the development of science by including all the sciences in separate compartments. Therefore, on the basis of the principles of logic, a two-way relationship was established between the sciences, one giving a demonstration of fact, and the other a demonstration of a cause, and the resulting hierarchy to a certain extent ensured the fulfilment of the expected task.

KEYWORDS

Aristotle, Avicenna, Fārābī, Averroes, kind-crossing-prohibition, transfer of demonstration, relationships between the sciences, per se, premise, boundaries of the sciences.

INTRODUCTION

Aristotle wants us to be content with a study that can be done within the boundaries of logic, that is, to direct our attention to the science of objects using that logic, and to never even think of things as Plato, Pythagoras and other ancient Greek thinkers have said. He tries to distinguish and construct all sciences based on the principles of logic and its possibilities; and to accomplish his goal, he introduces certain restriction rules prohibiting a transfer of constituent elements which form the main structure of the sciences in a way contrary to the principles of logic; for according to him it poses a danger of breaking the order in the sciences. Hence, Aristotle forbids the improper transfer of demonstration from one science to another in order to challenge certain debates and views in his scientific studies.

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Given the fact that Aristotle's ban on kind-crossing has been attracting the attention of the historians of philosophy up to now, it is surprising that there is no any particular study concerning Arabic-Islamic philosophers' commentaries on this issue. Moreover, since Aristotle's theory of demonstration reaches its culmination with Avicenna, to examine a reception of this important and indivisible principle of the Aristotelian theory of science is vital to shed light on this uncharted area of the Islamic philosophy of science.

In Arabic commentaries on the Posterior Analytics Aristotle's doctrine on kind-crossing is mentioned as "transfer of demonstrations from one discipline to [another] discipline" (naql al-barāhīn min ṣināʿa ilā ṣināʿa) [9: 320], "shifting a proof from [one] science to [another] science" (naql al-burhān min ʿilm ilā ʿilm) [4: 169], "the transition of demonstration from one genus of the sciences to another genus" (naql al-burhān min jins min al-ʿulūm ilā jins ākhār) [2: 67], and "shifting from one genus to another genus" (al-intiqāl min jins ilā jins ākhār) [2: 275]. However, since the very term "demonstration" corresponds to the process of establishing the truth or justifying the truth of the judgment, we cannot transfer the process or an act, so what is the thing that is transferred? A demonstration in Aristotle and Avicenna is a syllogism that produces scientific knowledge. Thereby when we shift a proof from one science to another one, we do it by transferring one of the constituent elements, that is, per se terms, premises or accidents of the demonstrative syllogism to another.

In the following, I will first introduce Avicenna's account of kind-crossing and argue that it derives from the concept of per se. Since many detailed studies on Avicenna's account on the role of per se accidents in demonstrations have been conducted in recent years, I will not dwell too much on this issue, but rather, will concern with per se relation of all terms to each other and how it makes impossible to cross boundaries of the particular type of syllogism. I will then proceed to analyze Fārābī's account of kind-crossing. Lastly, by way of example of geometry-optics relations, I will analyze the role of the middle term in transferring the demonstration between two sciences.

Avicenna on Kind-Crossing

At the final passage of Burhān II.5, Avicenna introduces Aristotle's doctrine of kind-crossing prohibition:

When the middle term holds per se of the minor term and the major term also holds per se of the middle term, it is not possible to cross from one science into another science [3: 154].

This passage is crucial from two points. The first, it clearly proves that modern editorial division into chapters of Aristotle's Posterior Analytics, particularly A6 and A7 is completely misleading here as Barnes [1: 130] and Steinkrüger argue [10: 41]. The second, it becomes also clear that Aristotle's kind-crossing prohibition emerges from the concept of per se-belonging what Bechler calls "group-containment conception of syllogism" [8: 132, 157] and on what Steinkrüger builds his argument and presents his interpretation as a new one [12: 107-158].

As mentioned above, Avicenna requires that the constituent elements of the demonstrative syllogism, that is, their terms should hold of each other per se. Let us first consider the meaning of belonging of the middle term per se to the minor term and the major term per se to the middle. In Burhān, Avicenna himself illustrates a good example. He assumes "having an internal angle-sum equal to 2R" to be a middle term, "triangle" a minor term, and "having an internal angle-sum equal to a half of angle-sum of the quadrilateral" a major term [3: 91]. If we present it in a syllogistic chain:

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Major Premise: An interior angle-sum of a triangle which is equal to 2R makes it also equal to the half of the interior angles of the quadrilateral.

Minor Premise: Triangle is a figure the interior angles of which have a sum equal to 2R.

Conclusion: Triangle is a figure a sum of interior angles of which is equal to the half of the interior angles of the quadrilateral.

The middle term ("having an interior angle-sum equal to 2R") in the above syllogism constructed from Avicenna's examples is truly per se attribute of the minor term ("triangle"), likewise the major term ("having an internal angle-sum equal to a half of angle-sum of the quadrilateral") is per se attribute of the middle term. Therefore, we can assume in Aristotle's notion that it is a scientific syllogism. This syllogism is related to the "triangle" which is the subject matter of the geometry and does not exceed the boundaries of per se attributes of the triangle. In the same way, nothing is subjoined to the triangle which does not belong to it per se, and the demonstration is made up inside the domain of geometry. Here, we may see the relationship between triangular and rectangular shapes. Accordingly, if in the demonstrative syllogism all three terms belong to each other per se, it is impossible at all to go beyond the boundaries of a science in examination. Furthermore, it is impossible even to add some per se attributes of circle, another geometrical figure which means that kind-crossing can occur even within a single science as Steinkrüger argues [12: 109-110].

After introducing ban on kind-crossing, Avicenna states the requirements that demonstrative syllogism should meet to avoid illicit kind-crossing:

Rather, each science is explained by proper premises, for instance, geometricals by demonstrations proper to geometry, and arithmeticals by [demonstrations proper to] number. None of the transferred or distant explanations enters into any component of a science except what they share in common – we will explain it later, – hence, the premises will be related to the conclusion [3: 154].

Since all three terms in the demonstrative syllogism should be homogenous, it naturally emerges that the premises of the demonstrations should also be per se. Being proper and related of the premises in demonstration, necessarily makes them locating in the scope of particular genus. In this type of syllogism using its demonstration to explain premises located in the scope of another genus is automatically impossible. Avicenna follows Aristotle's argument about the impossibility of demonstration of a conclusion which pertains to one science from premises any of which, or any of whose terms, pertains to a second [7: 110]. For Avicenna, proper premises of the demonstration are the causes of the conclusion and since the causes are essentially prior, the premises of the demonstration necessarily should be essentially prior [3: 106]. The premises must precede conclusion in terms of time and knowledge, because the conclusion of demonstrative syllogism is known only by them. So, the premises must be true in order to give true conclusions. Since premises constitute a cause, they should meet following requirements:

(1) to be related to the conclusion;

(2) to be included in the integrity of the knowledge on which the conclusion is found or

(3) to be included in a common knowledge [3: 106].

In addition, the principles of these premises should be (i) evident by themselves and (ii) be better known and prior than all subsequent premises. Premises are not demonstrative if they do not meet aforementioned requirements. Moreover, since the premises of demonstration mean unchangeable knowledge and it is impossible for what is known by that knowledge to be in other condition, the state of the demonstrative premises cannot be otherwise and

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their predications should be per se. Avicenna calls this type of relationship between the demonstrative premises as "necessary relation" [3: 120, 150].

The premises forming the demonstrations can be sometimes common, but excluding things such as arithmetic and geometry, whose subjects are different by nature. Therefore, it is not possible to transfer the demonstration in which the issue was explained in one science in which the issue was explained in the other. The reason for this is that the essence of the number is different from the essence of the magnitude, since one is discrete quantity and the other is continuous quantity. According to Aristotle, the demonstration on the arithmetic proposition should not exceed the nature of the number, that is, all three terms in the demonstrative syllogism in which an arithmetic proposition is studied must be of the same genus [1: 13].

Avicenna states Aristotle's example of the distinction between the subject-matters of arithmetic and geometry which study different kind of quantities [13: 116]. Their subject-matter absolutely differs from each other without any interference because one of them deals with discrete quantity and the other with continuous one, that is, arithmetic and geometry have quite different relations with their per se accidents. In other words, the relations between the elements of the geometrical objects depend on adjacency. If the relations of particular genus maintain particular properties, it is impossible to understand them through another genus which does not support that relation or reduce them to that genus. On the other hand, the number depends on sequence. Therefore, it is impossible to talk about the symmetry while discussing numbers, for instance if A is a sequence of B, the latter cannot be a sequence of the former, for they are related to each other only in one direction. Because of the differences between those two types of relation, any geometrical object cannot be reduced to a number, that is, we cannot understand any geometrical thing through the genus of number. Averroes, another prominent commentator of the Posterior Analytics corroborates Avicenna's statements saying what is meant as per se attributes are things common to those of more than one genus and are predicated not as synonyms but as homonyms, for example, as we attribute "equality" to continuous and discrete quantity, because "quantity", since the noun "quantity" is predicated to these two via homonymy [2: 278]. For what is doubtful about it are examples of such premises. Therefore, Averroes states that it is impossible to transfer the demonstration, that is, the major premise, or both of the two premises from one science to another [2: 278]. For example, "equality" requires that A1 (arithmetic) and A2 (geometry) sciences, which fall under the genus A (quantity) and whose subjects are completely different from each other, should be proved with a different middle term. However, since "equality" is a general concept like quantity, it should be made a proper middle term in order to make a practical contribution to the solution of a specific proposition in both A1 and A2 sciences.

However, how the fact that the premises of the demonstrative syllogism are necessarily in per se relationship with each other makes the transfer of the demonstration from one science to another impossible? We may try to answer this question as follows: Per se attributes are the elements that in some sense are similar to each other or have similar characteristics. These elements gather in a set called "genus" and do not cross its boundaries. Moreover, they do not accept, more precisely, they cannot accept foreign elements or particles from a different set, since a foreign element taken from another set creates the danger of disturbing the order in this set. However, under certain circumstances certain elements may be allowed to ply between different sets. From this, we

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may imagine the sciences, in a sense, as organic. For example, when we look for the reason why circular wounds heal more slowly than linear wounds from geometry, we carry a premise from a foreign science to medicine [5: 106]. Therefore, there is no singular other than the thing that is included in art in demonstrative sciences. What included in art is either the subject or the things acting as the subject-matter of science. Avicenna thus divides the difference of the subjects of the sciences into two by saying that it is either absolute difference without any interference, or by some interference, such as sharing common thing with the other in anything [3: 162]. Except for what they have in common, it is not possible for any distant explanation to enter into any science. From this point of view, it can be said that the demonstrations only examine per se attributes of the subjects and those attributes are only found in those subjects and the types of subjects. If these personal attributes are denied to have any presence in a group of the subjects and subjects in question, they are among the impossible. However, how does this illicit crossing occur?

In the beginning of Burhān II.8, Avicenna states two types transfer of demonstration, and the first one is an invalid one and occurs as follows:

One thing is taken as a premise in one science but its demonstration is in another science. Hence, it is received in this science and its demonstration is transferred to that science [3: 169].

According to Avicenna, if any premise of the demonstrative syllogism is not of the same genus with the other premise used in that syllogism, but on the contrary, it means that premise is transferred from a different science. Since the premises of the demonstrative syllogism are the cause of the conclusion, their predicates must be per se. Because if the predicate does not exist in any premise per se, it means that it is transferred from a foreign science. This is why, as was mentioned above, in order to prevent an improper transition from one science to another, the middle term must belong to the minor term per se and the major term to the middle term per se respectively. Therefore, it is absolutely not possible for different sciences which are not subordinated to each other, to share a special principle. It is not possible for one term from these sciences to neither act as a middle term nor be in the superordinate science, nor in the subordinate science. There is not an actual relationship in different sciences; rather there is only a potential relationship. In addition, since the subjects of the scientific propositions are either the genus of the subject of science or a type of the subject, or per se attribute in it, it is not possible that the minor premises are constituted from common principles in any way. From all the premises in science only conclusions related to those premises draw. Even any principle of a science is not suitable for all the propositions of that science. Therefore, the predicates of the demonstrative syllogism must belong to each other per se. Likewise, it is impossible for two sciences with different subjects to have a single per se attribute, because this per se attribute should be taken in the definition of the genus of science, that is, in its subject. If the thing taken in its definition is the genus of science, then that thing is specific to that science. But if what is taken in its definition is the genus of that science, that thing is primary and original for the genus of that science, and its existence in that nature is known only by the fact that we assume it as the genus of science, that is, it's being in nature, which is more general than the genus of science. In short, its relation to the genus of science is as in the example of Aristotle, where the interior angles of an equilateral or different triangle are equal to two right angles. When this is the case, science puts what is not of its kind as a genus.

The characterization of linearity and circularity as the corresponding intrinsic features of the line by Avicenna reflects the criticism of Bryson's efforts to

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square the circle for not making a premise, he used an appropriate one. It is impossible to change their place, since these two accidents are within the scope of a specific genus and are in opposition to each other. Fārābī says that Bryson's effort to square the circle is non-per se fallacy, carried from a universal science that encompasses particular sciences, since the premise he used is not a matter of concern to the geometer as it encompasses both geometry and arithmetic. While Avicenna criticizes Bryson's effort to square the circle, he first states that his proposition is logically wrong. He says that the premise Bryson used "things bigger and smaller than the same thing are equal to each other" is specific to quantity in general, not to geometry, since it has not been made an appropriate principle. Avicenna says that it is only potentially possible to find a quadrilateral (or polygon) equal to a circle, that is, when we assume the circle as an intermediary figure between the potential and infinite figures within itself and the potentially infinite figures surrounding it, it is certainly possible to find a figure that is larger than all inside and smaller than all outside among these infinite figures. As a result, the circle and that rectilinear figure will be equal. However, when we imagine the figures as certain figures rather than infinite, there will be no straight-line figure equal to the circle. Because in this case any figure inside and outside the circle will be either smaller or larger than the circle. If we assume the figures inside and outside as potentially infinite figures, a linear striped figure equal to the circle can be found.

With such a method, Avicenna admits to find a polygon that is hypothetically equal to the circle, but for this, the method specific to metaphysics will be used, not the method proper to geometry. Since calculating the area of a circle or rectangle is not an issue that metaphysics examines, when we try to do this with the metaphysical method, we confuse geometry with metaphysics. Avicenna therefore says that the syllogism Bryson used is not demonstrative, but rather dialectical or logical, and calls him "the one who imagines himself as a geometer". Because the syllogism he used was not related to the subject specific to geometry, he made a mistake in geometry and went beyond its boundaries [3: 176]. Demonstrative syllogism, on the other hand, is in the scope of the genus of the issue under consideration and should be related to it. The accepted syllogism, whose premises are not related to the conclusion, belongs to the dialectic.

Fārābī on the Boundaries of the Sciences

Perhaps, a short survey of Fārābī's, Avicenna's predecessor and another Arabic Commentator of Aristotle's Posterior Analytics, account on illicit kind-crossing will be useful to understand how such an invalid transfer occurs. Fārābī defines things that give rise to the errors in the principles of the sciences or in things after principles as "fallacies", and divides them into 1) per se ones and 2) non-per se ones. Non-per se fallacies are those that are impossible for a particular investigator to study. For example, it is impossible for geometer to investigate such fallacies in geometry. Fārābī states that non-per se fallacies are things that are carried from one science to another contrarily to the hierarchical relationship rules, in what lower science grasps its principles from the higher science: in other words, what Fārābī calls "non-per se fallacy" is actually a demonstration that is illicitly transferred from one science to another. Fārābī divides such fallacies into two parts: (1a) the fallacy transferred from a science surrounding (i.e. general science) the particular sciences, and (1b) the fallacy transferred from one particular science to another. Fārābī says that although non-per se fallacies can be transferred between sciences sometimes correctly and sometimes incorrectly, they are not examined in the science they are carried and for (1b) he provides an example of explanation that has been transferred from natural science to geometry:

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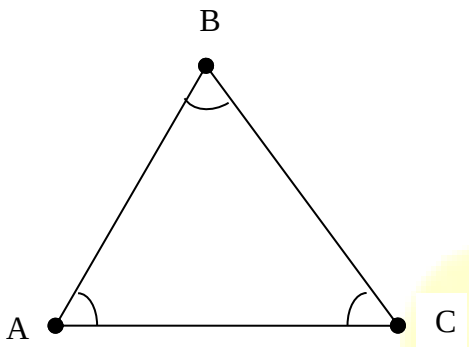
The sum of the two sides of ΔABC is longer than the third.

AB + BC> AC or if ΔABC is equilateral: AB + BC = 2AC.



If we try to explain this in a different way:

Suppose that if two objects in ∠A set off at the same time and at the same speed to reach ∠C, one moving from the edges AB and BC and the other from the AC edge, The object moving from the edges AB and BC travels twice or more than the object moving from the AC edge. Thus, we conclude that the sum of sides AB and BC is longer than the AC side. However, Fārābī says that this kind of explanation is not proper to geometry; on the contrary, it has been transferred from natural science to geometry because it contains movement. Fārābī is of the opinion that this form of explanation does not conform to the hierarchical relational rules that allow the proof to shift from one particular science to another, as in the geometry-optics or arithmetic-music relations, and therefore says that such explanations do not fall within the scope of the geometer's study [9: 343-344]. (1a) is the misleading type of Bryson's effort towards squaring the circle, which can be given as an example, since the premise he uses does not concern the geometer, as it encompasses both geometry and arithmetic.

Transfer of Demonstration between the Sciences by the Middle Term

The sciences in hierarchical relations where one gives the reason of fact and the other the reason why are exempted from this prohibition rule. According to Aristotle and his Ancient Greek and Islamic commentators, hierarchical relations between sciences mean that one science is under another. The subordinate science is considered more specific than the superordinate one, and it is considered to be more general than the subordinate ones and which provides the principles and reasons for it. These kinds of sciences take place between the natural science and arithmetic/geometry, pure abstract mathematical sciences. For this reason, they are called middle or mixed sciences. The installation style of these sciences, which are in an ontological hierarchical relationship with the abstract sciences and natural science, allows the demonstration to be transferred among these sciences. Below, we will try to examine the understanding of Islamic philosophers and scientists regarding the functioning of such sciences.

Avicenna, following Fārābī, says that the middle term assumes the determining role in the transfer of demonstration between the sciences:

One thing will be taken as a required thing in one science, and then it will be proved by the

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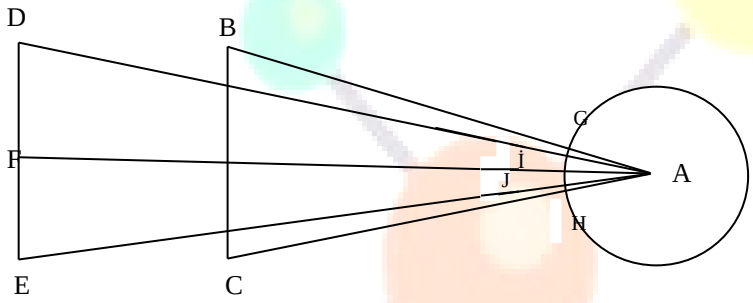
demonstration the middle term of which is from another science. Therefore, the parts of the syllogism will be valid to take place in two sciences [3: 116].

According to Avicenna, if the cause for the proposition under investigation in A2 science, which is more particular, is explained in the more general A1 science, these two sciences are common, that is, the transference of the demonstration can occur only when one of the two sciences is under the other [3: 116]. Avicenna gives an example of bringing the cone of the eye as a geometric demonstration in optics Avicenna says that even if the cone is abstracted relatively to the eye, this demonstration will be the same for it, since the reason for this is that the middle term belongs to the geometry that examines the more general subject and the minor term belongs to the optics that examines the more particular subject, and thus the optics has its lines adjacent to the eye [3: 111]. He states that optician examines per se attributes of the lines by taking it as a subject. In Danishnama Alai and Uyun al-Hikma, influencing by Euclid's Book of Optics, he explains the small appearance of what is far away, by a geometric demonstration, that is, it shows how it functions in practice.



Avicenna considers the circle centered A as the eyepiece, BC and DE as two lines of equal length at a certain distance from the circle. Then he draws the vertical line AF from point A over both BC and DE. Then draws the lines AB, AC, AD and AE from point A to the end of each of the lines BC and DE, creating two isosceles and ΔABC and ΔADE whose bases are equal. In this case, ΔADE is higher than ΔABC, ∠DAE is narrow and ∠BAC is wide. IJ curves pass through ∠DAE and GH curves from ∠BAC. The GH curve is larger than the IJ curve. Avicenna says that the image in BC will be seen at the GH arc of the eye lens, and the image in DE will appear at the IJ arc. Thus, as the image in DE is farther from A than BC, the IJ curve becomes smaller than the GH curve and the image in DE is seen smaller than the image in BC. Avicenna therefore states that the image in DE is seen through less particles of the lens of the eye, and if the position of the image is small, the image will also appear small. According to Avicenna, what appears this way is what appears to be real. Avicenna thus concludes his own explanations by stating that the acceptance of the image is not determined by the encounter of the lens of light, but by the small angle that causes the thing to be seen smaller. It is seen that the postulates and propositions mentioned in Euclid's Book of Optics were also influential on Averroes. Because Averroes following Avicenna says that what belongs to geometry that causes the distant thing to appear small the optician will take as the reason for what appears in his own science. Averroes states that if the lines emerging from the center of the cone are longer than the center, the angle of the cone will be small, and if we take into account the small appearance of what appears from a certain angle, it becomes clear

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why geometry gives the reason for the propositions in optics [2: 278].

Avicenna tries to enlighten the issue of hierarchical relations allowed between the sciences with the example of "potentiality", which is one of per se attributes of the being: if the middle term comes from another genus, it must be a higher genus and be transferred to a subordinate one. Because the middle term is in itself in the superordinate science, so we get per se reasons there. For this reason, when the demonstration is transferred from the higher science to the lower one, the thing that is not from it, that is, the reason, is added to the lower science. If we conceive scientific research as a syllogism again, if the middle and major terms are the genus of the minor term, their essence or one of their constituent elements, that is, when a logical hierarchical relationship is established between all three terms, it is permissible to transfer the demonstration between the sciences and this transference is realized by turning from general science to particular science. Therefore, the demonstration can only be transferred when the sciences are common in one or more of their constitutive elements, that is, predicates, axioms, and established natures.

According to Tūsī, who comments on the issue of the transfer of demonstration in Avicenna's al-Ishārāt, the fact that something is taken as a proposition in a science but its demonstration necessarily is from a different science, expresses the second meaning of the transfer of demonstration, since it is transferred from a different science to explain that proposition. Tūsī, like other philosophers, presents optics and music as an example of this kind of transference and states that the demonstrations of these two sciences have a share in geometry and arithmetic. For, he says if there are propositions about the light of the eye and the tones of sound, these propositions are the same as those in arithmetic and geometry. According to Tūsī, the situation of these propositions does not change due to this similarity and the demonstrations used in geometry and arithmetic can also be transferred to optics and music. Tūsī says that music is therefore under the science of arithmetic, not natural science, but he does not explain the details [14: 480].

Averroes says that it is customary for numerical proportions to cause harmony of harmonious sounds in the science of music. Fārābī, Avicenna and Averroes say that general science sometimes can derive its principles from the particular science under it. For example, metaphysics derives its principles from natural science and mathematics; for the metaphysician accepts the existence of discrete objects from the natural scientist, and their number from the astronomer. Thus, the difference between metaphysics and other sciences regarding the exchange of principles is that particular science gives the principle of fact, not the principle of reason of a proposition in general science. General science gives the principle of reason in particular science, and it does not give general science something that can be used as a middle term in it. On the contrary, particular science gives general science what may be the subject or part of this general science, whereas general science gives particular one what can be used as the middle term in it.

Thus, all three philosophers say that there is some kind of relationship in sciences, and thanks to it, one science can use the principles explained in another. This relationship often occurs when one science is under the other, that is, as in the example of geometry-optics, particular science derives its principle from general one. The superordinate science gives the subordinate one the reasons it demands. The use of the major premise of the demonstrative syllogism, which gives conclusions in other science, can only be realized when one science is under another science, that is, particular science uses the major premises that

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are conclusions in general science. Avicenna states that this relationship between the sciences is not exactly a relationship in proportion, and it is not an equal-meaning relationship since the relation to what is studied is not the same. In other words, according to the main claim of our philosophers, including Aristotle, the main difference of numbers in music from numbers in arithmetic is that they are "sound numbers", and the lines in other sciences that are under geometry except optics are lines with the width. For this reason, Fārābī states that there is a matter in the definitions of the subjects of the sciences under arithmetic and geometry. Therefore, this feature of them should be taken into consideration in the studies in these mixed sciences.

Therefore, according to Aristotle, geometry does not explain that the science of opposites is one science, or the metaphysician does not explain that two cubes are one cube; no science explains what is specific to another science. This can only happen when one science is under the other, just as in the case of the geometry-optics and the arithmetic-music relations [1: 13]. It is impossible for the demonstrative particular science to explain what is peculiar to the demonstrative universal science that examines the being in terms of being, since the three terms in which the demonstration is formed come from the nature of the genus. For this reason, geometry does not examine opposites, unity and multiplicity. Likewise, a demonstrative particular science does not study what is specific to another demonstrative particular science. Averroes refers to the sciences that examine some types of beings as demonstrative particular sciences, and the science that examines the being in terms of being as demonstrative universal sciences. Even if the demonstrative particular science examines one of the attributes of the demonstrative universal science, it examines it in terms of being close to its subject and even making it appropriate to its own. For example, astronomer and natural scientist investigate the same thing, but the astronomer studies it in terms of abstraction from the matter, the natural scientist studies in terms of the limit of the nature of the celestial body; so, what gives reason why in one does not give reason why in the second, since the astronomer says, "the shape of the sky takes the shape of a sphere because the lines that come out from it to the center are equal". The natural scientist says, "It has acquired the spherical shape because of its spherical movement and because of its following nature". The demonstrations like this are not transferred. The three terms of the demonstration, namely major, middle and minor terms, are all included to the genus of science and the demonstration cannot be transferred from one science to another, since they are per se and do not cross the boundaries of the genus. The demonstration, then, can only be transferred when it is either absolute or one in one direction. According to Averroes, Aristotle said that it is not possible for a science to explain what is specific to another science, whether they are particular or one universal and the other particular, by which he meant the differentiation of sciences from each other [2: 282-284].

CONCLUSION

Medieval Arabic commentaries on Aristotle's theory of demonstration make clear that the prohibition of kind-crossing is due to the concept of per se which corresponds to being of the same nature. The elements of the same nature, i.e., per se attributes gather in a set called "genus" and constitute the infrastructure of the propositions that it will examine. This infrastructure constitutes the subject of a science, respectively. Thus, anyone who conducts scientific research has to justify the fact that his reasoning is real and reveal the inherent causal relationship between these particles in the process of constructing the truth. Otherwise, scientific knowledge will not be obtained. Aristotle's insistence that linearity and circularity are

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disproportionate, both physically and geometrically, is considered an example of this, and the ancient Greek and Islamic philosophers reject any effort to overlap these two corresponding individual particles of the line. Certain limitations imposed by Aristotle on kind-crossing aimed to ensure their development by separating the sciences in terms of subject, principle and issues. This restriction, based on the concept of per se, tightly linked the terms and premises that are part of the demonstrative syllogism, leaving no gaps where the middle term plays a determining role in transfer of demonstration. In other words, when we do scientific research in the form of syllogism, the demonstration is transferred from one science to another by the middle term. As a matter of fact, the main purpose of determining the boundaries of the sciences was to establish the theoretical basis of scientific research and to ensure its sustainability.

However, it was not possible to talk about the development of science by including all of the sciences in separate compartments. For this reason, a bilateral relationship was established between the sciences, again based on the principles of logic, as an exceptional case of the restriction rule, one giving the fact and the other the reason, which ultimately ensured the fulfillment of the expected duty to a certain extent. Thus, ban on kind-crossing demands that the per se accidents of the genus under investigation should be taken into account, whether a research is conducted in a single science such as arithmetic and geometry, or in science that includes dual relations such as optics or music. Although the lower-level sciences, which are in an ontological hierarchical relationship with the abstract sciences and natural science, or in other words, the mixture of these sciences, are exempted from the prohibition rule of Aristotle, the method of operation of the demonstration in these sciences is in fact more ambiguous than the rules determined by Aristotle. The fact that these sciences, in the words of Fārābī and Avicenna, do not share exactly with the above sciences, and the fact that there is more or less matter in the definitions of their subjects show that the nature of these sciences has been transformed in a sense.

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