AL QÛHÎ ON THE POSSIBILITY OF INFINITE MOTION IN FINITE TIME[1]

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The article of Al Qûhî (second half of the tenth century), whose text and translation are given below, exists in manuscript form in the Ayasofya Library, Istanbul (N°. 4830, p. 180*b*-181*a*). It is mentioned by Brockelmann (*Gesch. Arab. Lit.*, S. I., p. 399).

The ideas contained in this short article of Al Qûhî are clearly reminiscent of certain developments which took place just before the time of Galileo and which were undoubtedly of great importance in preparing the way for the Galilean physics. The contributions of Benedetti especially were of significance. This was a movement in the direction of the mathematical treatment of motion and constituted an attempt to apply mathematical reasoning to mechanics and thus to place that science on the 'secure and infallible' foundation of mathematics, and more specially, on geometry. Of course the importance of this mathematical method cannot be denied, and the occurrence of such an example, already in the tenth century, in medieval Islam is therefore of great historical interest. It could serve, moreover, especially if other examples of a similar nature can be found, for an evaluation of the relative significance of the mathematical method as leading to the initial developments of seventeenth century physics.

It has been estimated, on the one hand, that the paradoxes of Zeno blocked the road to the mathematical treatment of motion, and on the other hand, that under the influence of Aristotle Zeno's arguments were pushed to the background and that their value thus failed to be appreciated for a long time. Al Qûhî's article may be claimed to have the aer-marks of preoccupation with

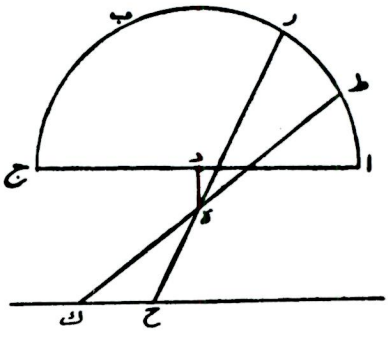
[1] The English sections of this article have also appeared in the *Acts* of the VIII th International Congress of the History of Science.

Zeno's paradoxes, although no reference occurs to them in the article itself. Indeed, the very title may suggest such a relationship. For it may conceivably be judged that if infinite distance can be traversed in finite time, it can no more be asserted that a finite distance cannot be traversed in an instant, and this would serve to defeat the object of Zeno's fourth paradox, sometimes called the stadium, and would thereby undermine all four paradoxes.

It may be pointed out that the example of mathematical method as given here by Al Qûhî has the characteristic of resting upon a concrete physical case related to optics. It does not deal with a material body, but it does not by any means disregard the factual realm either. It is pure kinematics, but it is accompanied by an illustration of the existence of a corresponding case occurring in nature. As will be noted, Al Qûhî assumes the propogation of light to be instantoneous.

It is of interest in this connection that, together with statics and astronomical kinematics, optics represented the branch of science in which, up to the seventeenth century, the process of mathematical treatment had been carried out more extensively and more successfuly compared to other scientific fields.

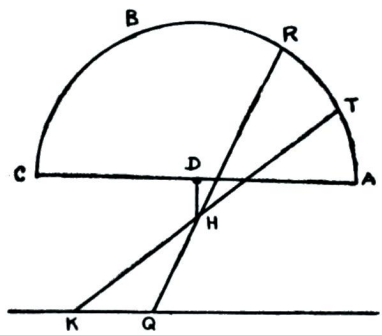
قول لابى سهل ويجن بن رستم القوهى على أن فى الزمان المتناهى حركة غير متناهية



نفرض نصف دائرة (ا ب ج) على قطر (ا ج) ومركزه نقطة (د) و نتوهم عليه شخصا قائما و هو (د ه) ونفرض شيئاً من الاشياء المضيئة قد ابتدى بحركة فى نصف دائرة (ا ب ج) من نقطة (ا) ووقع شعاعه على رأس الشخص بحركة الشيء المضئ على نقطة [ه] فاقول إن حركة [ظل] رأس الشخص بحركة الشيء المضئ فى الزمان المتناهى ليس له مبداء ولا منتهى لأنا لو فرضنا مثلا نقطة (ح) مبداء الحركة رأس الشخص ووصلنا بينه وبين رأس الشخص بخط واخرجناه مثل خط (ر ه ح) لكان يقع من نصف دائرة (ا ب ج) قوسا ما مثل (ا ر) واذا قسمنا ها بنصفين على نقطه (ط) واخرجنا منها خطا إلى رأس الشخص مثل خط (ط ه ك) لكان يقع على نقطة قبل تلك النقطة التى فى المبداء مثل نقطة (ك) وذلك محال وكذلك فى النصف الآخر فتبين أن حركة [ظل] رأس الشخص ليس له مبداء ولا منتهى وذلك ما أردنا أن نبين. تمت الرسالة والحمد لله وحده.

EBÛ SEHL VEYCEN İBN RÜSTEM EL KUUHÎ'NİN SINIRLI BİR ZAMAN ZARFINDA SINIRSIZ HAREKETİN İMKÂNI HAKKINDAKİ KISA MAKALESİ

(Türkçe Tercüme)



AC çapı üzerinde bir ABC yarım dairesi tasavvur edelim. D noktası bu dairenin merkezi olsun. Daireye D'de dikey olarak duran bir DH parçası tasavvur edelim. Yine, A'dan başlayarak yarım daire üzerinde hareket eden ışıklı bir cisim tasavvur edelim. Bu cisim hareket ederken ışını dik DH parçasının tepesi olan H noktasına isabet eder.

İmdi, ışıklı cismin sınırlı bir zamanda cereyan eden hareketi neticesi meydana gelen H'nin gölgesinin hareketi herhangi bir başlangıç veya müntehaya sahip değildir. Çünkü meselâ Q noktasının H'nin gölgesinin bu hareketinin mebdei olduğunu kabul eder ve bu nokta ile H'nin arasını bir doğru ile birleştirirek bu doğruyu R'ye kadar uzatırsak, bu doğru ABC yarım dairesinden AR gibi bir yay keser. Bu yayı T ile iki eşit kısma bölelim ve T ile H'yı bir doğru ile birleştirerek bu noktayı THK doğru parçasını teşkil edecek şekilde uzatalım. Böylece K gibi bir nokta elde etmiş oluruz ki, bu nokta mebde olarak kabul edilmiş olan Q'den daha başta bulunur. Halbuki bu muhaldir, ve aynı ispatı yarım dairenin diğer yarısına da tatbik edebiliriz.

Risale sona ermiştir. Hamd yalnız Allaha mahsustur.

AL QÛHÎ'S SHORT ARTICLE ON THE POSSIBLITY OF INFINITE MOTION IN FINITE TIME

(English translation).

We consider a semicircle *ABC* on the diameter *AC* and let its center be the point D, and we imagine an element *DH* placed perpendicularly to it. We also consider a luminous body moving on the semicircle *ABC*, starting from *A*. While it moves, its ray will fall upon the top *H* of the perpendicular element.

Now, I state that the motion of the shadow of *H*, which results from the motion of the luminous body and which takes place in a limited time, has no beginning and no end. For if we consider, e.g., the point *Q* to be the origin of the motion of the shadow of the top of the element and draw a straight line between this point and *H* and extend it so as to form *RHQ*, it will mark off from the semicircle *ABC* an arc such as *AR*. Let us bisect it at *T* and join this point with *H*, and then extend it so as to form a line such as *THK*. This will give us a point such as *K* which will precede the one which was taken as origin. But this is absurd, and the same argument applies to the other half of the semicircle.

It becomes clear therefore that the motion of the top of the perpendicular element has no beginning and no end, and this was what we wished to ascertain.

This is the end of the article, and gratitude is to God only.