X. *On the Height of the luminous Arch which was ſeen on* Feb. 23, 1784. *By* Henry Cavendiſh, *Eſq. F. R. S. and A. S.*

Read February 25, 1790.

THIS arch was obſerved, at the ſame time, at Cambridge by Mr. WOLLASTON; at Kimbolton in Huntingdonſhire, by the Rev. Mr. HUTCHINSON; and at Blockley near Campden in Glouceſterſhire, by Mr. FRANKLIN; and is deſcribed in letters from thoſe gentlemen read to the Royal Society in December 1786 *.

It has been remarked, that as the arches of the kind deſcribed in theſe Papers have uſually but a very ſlow motion, their height above the ſurface of the earth may readily be determined, provided they are obſerved about the ſame time, at places ſufficiently diſtant; and they ſeem to be the only meteors of the aurora kind whoſe height we have any means of aſcertaining.

The three places at which this phænomenon was ſeen are not ſo well ſuited for this purpoſe as might at firſt be expected from their diſtance, becauſe they lie too much in the direction of the arch; they however ſeem ſufficient to determine its height within certain limits, and perhaps are as well adapted for it as any obſervations we are likely to have of ſuch phænomena.

The latitude of Cambridge is 52° 12′ 36″: that of Kimbolton is ſaid by Mr. HUTCHINSON to be 52° 20′, and,

* See p. 43—46. of this Volume.

according to the ſurvey of Huntingdonſhire, publiſhed by JEFFERIES, is 52° 19′ 50″; ſo that we may ſuppoſe it to be ſeven geographical miles north of Cambridge, and by the maps it ſeems to be about 18 ſuch miles weſt of it: and Blockley is by the map 12 geographical miles ſouth and 72 weſt of Cambridge.

At Cambridge the obſervations of its track ſeem to have been made at about 9 h. 15′ P.M. or 8 h. ſidereal time. At Kimbolton, allowing for the difference of meridians, they could hardly have been made more than 5′ ſooner; and at Blockley they were moſt likely made nearly at the ſame time as at Cambridge.

At Blockley the arch paſſed about 7° ſouth of the zenith; but it is unneceſſary to determine this point with preciſion. At Kimbolton it was found by a quadrant to paſs 11° to the ſouth of it; and at Cambridge it was obſerved to paſs through δ and ε Tauri, β Aurigæ, θ Urſæ majoris, Cor Caroli, and Arcturus. Now, if an arch was drawn through theſe ſtars, it muſt, I think, have appeared ſenſibly waved to the eye; whereas Mr. WOLLASTON did not take notice of any crookedneſs in this part of its courſe. It is moſt likely, therefore, that the middle of the arch muſt have paſſed to the ſouth of β Aurigæ, and to the north of θ Urſæ; and if a circle is drawn through δ Tauri, Arcturus, and a point one degree north of the zenith, it will differ but little from a great circle, will agree as well with the poſitions of theſe ſtars as any regular line which can be drawn, and will paſs 2½ degrees below β Aurigæ, and as much above θ Urſæ; which is not a greater difference from obſervation than may well have taken place, conſidering how much care and acquaintance with the fixed ſtars are required to determine a path by them ſo nearly.

The direction of the arch here deſcribed in that part near the zenith is W. 18° S.; and if a line is drawn through Cambridge in this direction, Kimbolton is 12,8 geographical miles north of it; and therefore, as the arch appeared 12° more ſouth at Kimbolton than at Cambridge, the height of the arch above the ſurface of the earth muſt be 61½ geographical or 71 ſtatute miles. If we ſuppoſe that the middle of the arch really paſſed through β Aurigæ, the height comes out 52 ſtatute miles. On the whole, I ſhould think, the height could hardly be leſs than 52 miles, and is not likely to have much exceeded 71.

The common aurora borealis has been ſuppoſed, with great reaſon, to conſiſt of parallel ſtreams of light ſhooting upwards, which, by the laws of perſpective, appear to converge towards a point; and when any of theſe ſtreams are over our heads, they appear actually to come to a point, and form a corona. Hence, from analogy, it ſeems not unlikely, that theſe luminous arches may conſiſt of parallel ſtreams of light, diſpoſed ſo as to form a long thin band, pretty broad in its upright direction, and ſtretched out horizontally to a great length one way, but thin in the oppoſite direction. If this is the caſe, they will appear narrow and well defined to an obſerver placed in the plane of the band; but to one placed at a little diſtance from it, they will appear broader, fainter, and leſs well defined; and when the obſerver is removed to a great diſtance from the plane, they will vaniſh, or appear only as an obſcure ill-defined light in the ſky.

There are two circumſtances which rather confirm this conjecture: firſt, that though we have an account of another arch beſides this * having been ſeen at great diſtances in the

* That of Feb. 15, 1750. Phil. Tranſ. XLVI. p. 472. and 647.

direction

direction of the arch, we have none of any having been ſeen in places much diſtant from each other in the contrary direction; and, ſecondly, that moſt of them have paſſed near the zenith, whereas otherwiſe they ought frequently to appear in other ſituations; for if they appeared near the zenith to an obſerver in one latitude, they ſhould appear in a very different ſituation in a latitude much different from that.

I wiſh it to be underſtood, however, that I do not offer this as a theory of which I am convinced; but only as an hypotheſis which has ſome probability in it, in hopes that by encouraging people to attend to theſe arches, it may in time appear whether it is true or not. If it ſhould hereafter be found, that theſe arches are never ſeen at places much diſtant from each other in a direction perpendicular to the arch, it would amount almoſt to a proof of the truth of the hypotheſis; but if they ever are ſeen at the ſame time at ſuch places, it would ſhew that the hypotheſis is not true.

Suppoſing the hypotheſis to be well founded, the height above determined will anſwer to the middle part of the band, provided the breadth of it was ſmall in reſpect of its diſtance from the earth, but otherwiſe will be conſiderably below the middle. If the breadth of the band was equal to the diſtance of its lower edge from the earth, the height of the lower edge would be three-fourths of that above found; and if the breadth was many times greater, would be half of it.

In the common aurora borealis, an arch is frequently ſeen low down in the northern part of the ſky, forming part of a ſmall circle. What this is owing to, I cannot pretend to ſay; but it is likely that it proceeds from ſtreams of light which appear more condenſed when ſeen in that direction than in any other, and conſequently that the ſtreams which form the arch to an obſerver

in

in one place are different from thoſe which form it to one at a diſtant place, and conſequently that no concluſion as to its height can be drawn from obſervations of it in different places. Attempts, however, have been made to determine the height of the aurora from ſuch obſervations, and even from thoſe of the Corona*; though the latter method muſt ſurely be perfectly fallacious, and moſt likely the former is ſo too.

* Bergman. Opuſc. Vol. V.